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CHILD DEVELOPMENT AND THE INTERPRETATION OF BEHAVIOR[1]

By Professor JOHN E. ANDERSON

DIRECTOR OF THE INSTITUTE OF CHILD WELFARE, UNIVERSITY OF MINNESOTA

A YEAR ago upon this occasion, Professor Walter R. Miles delivered an address in which he presented the results of a series of studies upon longevity and senescence. To-day, I propose to start with the opposite end of the life process and consider some of the theoretical implications of modern studies of infant and child development. Since titles for vice-presidential addresses are sent in much in advance of their delivery, this paper has greater scope in its title than in its content. For it started to discuss the implications of several principles and ended with one; thus illustrating its final topic, the movement from generalized to specific behavior.

Despite some differences in detail and in the interpretation of results, it may quite fairly be said that in the early stages of all responses studied genetically, behavior is more generalized, partakes more of the nature of mass activity, involves more of the whole organism, than is true of that behavior observed later in time. Coghill[2] has elaborated upon his phenomenon and discussed some of its implications. It appears alike in studies of prenatal and infant behavior and in the studies of older children. Sometimes this early behavior is described as mass activity or diffuse movements of the whole organism; in other instances as a likelihood that almost any response may be obtained on the first application of a stimulus, known

[1] Address of the vice-president and chairman of the Section on Psychology I, American Association for the Advancement of Science, St. Louis, Missouri, December 31, 1935.

[2] G. E. Coghill, "Anatomy and Human Behavior." Macmillan, 1929.

later to elicit a specific response. Early behavior seems to possess some degree of fluidity, diffuseness, of lack of organization in contrast with its later fixity, precision and organization. In the discussions of this phenomenon, among other terms "individuation" and "differentiation" have been used to describe the developmental course. Both terms emphasize internal process, and perhaps even imply that the process described would go forward in a minimal environment. That a good case can be made for such a position, if attention is confined to prenatal and early infant behavior, is rather widely admitted. But it can also be shown that this phenomenon is characteristic of all the adjustments of the organism, whatever the stage of growth.

The thesis of this paper is that specificity of behavior is a result of external necessity, rather than of internal constitution. It arises because the environment demands that responses be simple, integrated and specific, in order to be effective in a world of objects in space. Objects must be lifted, moved, thrown, manipulated; in other words, directed energy must be applied to them at specific points. Generalized activity will not move a golf ball off a tee—highly specific activity will send it two hundred yards into space. As a result there is imposed upon response a selective process that results in specificity. Corresponding to increasing specificity of response there is progressive differentiation of the stimulus field. The final reaction of the organism is not to wholes in the sense that every potential stimulus in the environment bears some relation to the response, so much as to specific parts of the stimulus field, each of which has been sorted out in the history of the organism.

When all the response systems of the organism are considered another selective principle is involved. Since the organism is both structurally and functionally an independent unit with physical boundaries in a space world and is limited to a single major activity in a moment of time, there is imposed upon its potential abilities and partial skills a second selective process, in which some are chosen ahead of others for practice and progress toward specificity. The final result is an organization of behavior that is both specific and unique for each individual.

In order that these principles may operate, there must be in the organismal-environmental relation the material from which selection can be made. Both within individual systems of response, and within the responses of the organism as a whole, such material is available. But, the relation between organism and environment is not one of complete freedom for development in any direction; it is one which has definite limits.

Recent studies on infants and young children are clarifying our conceptions of these limits. Roughly they can be divided into types. Within any sensory field there are absolute limits beyond which a person can not respond and relative limits determined to some extent by past experience with particular types of sensory stimulation. On the side of physical structure and response there are limitations too frequently neglected in psychological discussion. Walking is perhaps not so much a neuro-muscular pattern as the only type of progression which can develop in a biped. How would human behavior differ if there were a universal joint at the elbow instead of a hinge? In Kellogg's[3] study structural differences in the hand of the chimpanzee and the human infant resulted in marked differences in their prehensive behavior on similar problems. There are also functional limitations which also arise out of the developmental level of the child at the moment. In the Hilgard[4] study of twins, a child of a given age level moved up to a limit of performance with continued practice. Weeks or months later, the control child, in a much shorter period of time, moved up to the same or a higher level of performance. Task limits become effective when the complexity of the task is not sufficient for the organism to show its potentiality. Mattson[5] has recently studied the relation between the complexity of tasks and behavior in a learning and relearning situation. There are functional limits under which might be included much of the material covered in our customary discussions of individual differences. Thus the behavior of the organism is definitely circumscribed by limitations arising out of structure, out of developmental level, out of task limits and out of the functional relation of the organism to the environment.

It would be interesting and worthwhile to make a more complete analysis of the limits which surround functioning at every turn, and to speculate on the possibilities of behavior were they different. But the comic papers have preempted this field with Pop-eye, Buck Rogers and a host of other characters. Even gravity, that physical limitation which controls all of us, seems to vanish in the comic strip.

Limitations are characteristic of all organizations of matter, whether living or inanimate. Iron ore, multi-potential in its original form, becomes, when fabricated, limited by its organization. A locomotive, for instance, can not be used for shaving, nor does it

[3] W. N. and L. A. Kellogg, "The Ape and the Child." New York: McGraw-Hill. 1933.

[4] J. R. Hilgard, *Genetic Psychology Monographs*, 14: 493–567. 1933.

[5] Marion L. Mattson, *Genetic Psychology Monographs*, 13: 299–398. 1933.

make a good hoe. In an organism so far along in the evolutionary process as the human being, there is already in the first appearance of any response system some degree of organization or limitation.

Instances of particular response systems may be examined in order to illustrate the operation of these principles. For this purpose responses that have been studied in great detail must be selected. For our interest is not so much in the presence of arbitrarily defined responses as in the variability and fluidity of response in its earliest appearances. As long as the approach to infant and child behavior was dominated by the view that reflexes were specific from the outset and that development consisted in tying them into chain reactions, little material was available. In the clinical approach, reflexes were looked upon as specific indicators and recorded or not recorded on the basis of arbitrary definitions. Far too often the investigator sorted out of a behavior matrix that which fitted such an arbitrary definition.

Two systems of response in infancy have been much investigated; one the plantar response and the other the sucking response. In accordance with our assumption we shall expect variability in the first appearances followed by selection as development proceeds with ultimate high specificity, if the response produces effects in the practical world.

Pratt[6] and Richards and Irwin,[7] working independently, recently made extensive and well-controlled studies of plantar reactions. Instead of one plantar response, Pratt finds that stimulation of a particular area may release several patterns of response, while stimulation of different areas may evoke the same response. To quote: "Out of 1,581 responses to stimulation of 13 different cutaneous areas, only 185 segmental patterns of response were discovered." "The fact that 4 (2 per cent.) of the response patterns—account for 29 per cent. of all responses—occur to stimulation of 13 different areas, that 12 (6 per cent.) accounting for 50 per cent. of the total responses—extend to stimulation of at least 10 different areas and that 27 (15 per cent.) accounting for 75 per cent. of all responses—extend to at least 7 different cutaneous regions, is sufficient evidence for the assertion that there is little rigid, specific limitation of the reflexogeneous zone."

What happens to these responses as the organism develops? For the answer we must turn to the Richards and Irwin study, which likewise found great variability and fluidity in early response patterns. To quote: "It would appear, therefore, that plantar responses in human development are variable and inconsistent at birth and probably during fetal life. Gradually, however, there emerges from this mass activity of the limb a more definite reactivity of the toes. Perhaps there emerges also from the mass activity of the toes a more definitive toe response, tending slightly at first to be of extensor character and eventually (at from six to eighteen months) of flexor character as well. Gradually all reactivity appears to decrease until at four or five years it has become negligible, and the characteristic result of plantar stimulation is the elicitation of no response whatever."

For sucking, Pratt, Nelson and Sun[8] found that, although produced by almost any type of stimulation, it was most frequently elicited by stimulation in the mouth region. In studying differential reactions to taste, in infants from 2 to 11 days old, they found 85 per cent. reactions, of which 29 per cent. were specific sucking movements and 71 per cent. movements other than sucking. They conclude (p. 209), "The infant at birth represents an organism in which differentiation has proceeded to a point where there are many effectors and receptors. Its behavior, however, is generalized; that is, stimulation of almost any group of receptors by almost any kind of stimulus will lead to a response in almost any part of the organism." To this statement Jensen adds the phrase, "which is set to respond." Jensen[9] finds that mass activity disappears immediately after the nipple is put in the baby's mouth, and that sucking becomes disorganized as the baby becomes satiated. Since Jensen's study was confined to the newborn no picture of the development of the sucking response is given. But Pratt, Nelson and Sun find that with increasing age the stimulus for sucking becomes more specific.

In these systems of response much greater variability is characteristic of their first appearance than previously supposed. But for the plantar response, which is of little or no significance in affecting the practical world, although variability is present in some degree for some years, ultimately both the response and the sensitivity associated with it disappears. With sucking on the other hand, there is rapid selection and fixation of a single response, since the internal drive of the organism is great, and the possibilities of precise behavior high. Generalized activity, if continued, will not insure a stream of milk. Undoubtedly there is a relation between the speed with which this selective process moves and the intensity of the drive and the adequacy of its satisfaction. But there is also a relation between the speed of selection

[6] Karl C. Pratt, *Jour. Genet. Psychol.*, 45: 22–38. 1934.
[7] T. W. Richards and O. C. Irwin, Univ. Iowa Studies in Child Welfare, 11, No. 1, pp. 1–146. 1935.
[8] Karl C. Pratt, A. K. Nelson and K. H. Sun, Ohio State University Studies. Contributions in Psychology, No. 10, p. 1–237.
[9] Kai Jensen, *Genetic Psychology Monographs*, 12: 361–479. 1932.

and the specificness and adequacy of the final response in its relation to the world of space and space objects. What is here stated is quite similar to the law of effect—with this exception—adequacy of response is not entirely a matter of what happens within the organism—it is also partially determined by adequacy in an environmental relation, *i.e.*, the readiness with which specific changes in the external world of objects are produced.

In learning, evidence of the essential variability of early response is at once apparent. Trial and error behavior and the progressive selection and fixation of response are familiar to all. There is both material for the selective process and clear demonstration of the final appearance of precise response. What is not quite so clear is that the speed of the process is directly related to the degree to which it is possible, by specific response, to produce change in a world of space and of objects in space. On the basis of this analysis we would expect that simple acts (simple in the sense that a particular result in the external world is readily produced) would become fixated more rapidly than complex acts (in which such an outcome is not so readily possible) and that there would be an intimate relation between the character of the goal object (to use Tolman's term) and the rate at which selection and fixation occur.

With development, in the case of a response that is of utility, there goes progressive differentiation of the stimulus field which parallels specificity of response. If, however, the response is of no utility, sensitivity disappears and the stimulus field, in spite of its original wholeness, becomes ineffective. Development and learning alike then involve a sorting over both of stimulus potentialities and response potentialities in the organism-environmental relation. In the earlier stages, the organism reacts to a wide variety of the stimuli with a wide variety of responses. As development or learning proceed some are sorted out so that ultimately the stimulus field becomes one of detail. To the novice a picture is a picture, a whole which is pleasing or not pleasing. To the artist it is a matter of areas of light and dark, of composition and balance, of proportion and perspective. Actually the artist sees more, because of the highly specific responses he has developed in order to produce effects in his own pictures.

In this process, what is the relation between differentiation and integration? In a former presentation Dr. Goodenough and I expressed ourselves thus: "Development proceeds from the generalized uncoordinated responses of the infant to the specific and highly differentiated behavior of the adult. There is, however, another aspect of the picture. Parallel with the process of differentiation which is the result of development, there is going on a process of integration or recombination of responses which is the result of experience. Although we may distinguish between these two processes theoretically, it is impossible to do so in actual practice since experience without development or development without experience are alike impossible. It is important to realize however that the complexity of the integrating or reorganizing process is directly dependent upon the degree of differentiation which has taken place."[10]

In our relations with material objects and with persons the constant demand is for single and simple responses. Generalized response in itself possesses no adaptive character beyond supplying the material upon which the selective process can operate to meet the demands of the environment. With the development of specific response, complexity comes, not so much on the response side as upon the situational side. Skilled behavior seems extraordinarily smooth and simple in comparison with unskilled behavior. But back of skilled behavior there is extraordinary complexity in a wide range of stimuli comprehended. As experience is gained, wholes are broken up into parts and specific reactions are set up. From the point of view of sensory process this is progressive differentiation. From the standpoint of response, the organism is engaged in building integrated patterns which tie elements of the stimulus field into functional wholes.

For instance, a boy may be able to catch a ball, to dodge and to run. Ultimately it will be necessary for him to receive a punt with opposing ends bearing down upon him. In this total situation, account must be taken both of the ball and of the approaching ends. If only the ends are perceived, he is likely to fumble; if account only of the ball is taken, he is likely to be thrown for a loss. If he reacts simultaneously to both the ball and the opposing ends, he may respond in such a way that yardage will be gained. Here is coordination of highly specific elements within the sensory field, plus a unified, integrated and single response. Effectiveness increases as the response becomes simple and as the range of apprehension within the sensory field increases. This principle, which holds clearly in the field of motor response, holds also in the field of symbolic process. Language symbols are highly specific and simple from the standpoint of their production; in their representative character they, however, increase in value as they subsume wider and wider ranges of experience.

[10] F. L. Goodenough and J. E. Anderson, "Experimental Child Study," pp. 25–27. Century Company, New York, 1931. Pp. 546.

For certain types of activity, we have been very successful, almost too successful through deliberate analysis in breaking up the series of responses that ultimately develop into component parts and arriving at a conception that, by emphasizing these component parts, we can somehow facilitate this whole procedure. Hence there arises the concept of the fundamental in our practical concern with educational and motor skills. But all too frequently, having taken the adjustment process apart, we can not put it together again. When the organism itself fractionates the stimulus field, an orderliness in the evolution of response results, that may or may not be duplicated if the field is artificially split. Only now are we beginning to see quite clearly that sound training procedures involve some retention of the original relation between stimulus field and response pattern and that fractionation is often better achieved through retaining this relation.

So far the application of the general principles to single systems of response has been discussed. It now remains for us to consider the whole series of responses appearing in the organism. Here likewise progress is from generalized to specific activity. The infant is multi-potential—*i.e.*, he possesses a repertoire of possible abilities, behavior sequences, skills, traits, etc., which supply the material upon which the selective process may operate.

Examined in detail, development consists in the appearance of multitudinous patterns, of which some originate as part of the progressive unfolding of the organism under intrinsic nature and some out of the environmental demand. The human being is not an organism who moves uniformly and in clock-like fashion from one point of time to another. Rather he is a continually shifting aggregate in which now this and now that and now the other structure or function spurts ahead or wanes. Almost the first characteristics of development that attract attention are increases in height, weight and the ability to meet the demands of life. Once we cut behind these obvious aspects of increase in size and ability, all is not so simple. For the human being is a complex of many structures and functions, which develop at different rates, reach terminal points at different times and deteriorate at different times and rates. If each is examined in detail, the growth process is found to be continuous in the sense that both in development and decay there are increments and decrements that are infinitesimal in amount. This principle, which can so readily be demonstrated for physical organs and external body parts, seems to be equally true of mental life. The conception of the growth of behavior as a weaving together of a whole series of growths and developments each of which has its own history rather than as a simple compounding of elements, is of comparatively recent origin. It is somewhat difficult to describe since we are so much under the influence of a type of thinking that seeks always to reduce behavior to its simplest elements and assumes that such elements can be found. If the elements themselves are in a continued process of flux, if there are no bricks out of which a wall of behavior can be built, then it becomes clear, I think, that we must think of behavior in terms of pattern and function rather than in terms of elements or component parts.

In the course of mental development many items of behavior run their course without being used in subsequent behavior, while upon others an overlay of behavior is erected. What persists, does so, in large part, because the environment selects from an organism of basic capacities those which are in line with its demands. This does not imply that internal and maturational factors completely disappear. But it does imply that the complete history of the organism can not be written in terms of those activities, skills and behavior patterns which persist to maturity. In the early vocal patterns of the infant a wide variety of sounds are to be found, many of which are not utilized in the language the child learns. Some sounds utilized in German but not in English are found in the vocal habits of American infants. For the American or English school child they are difficult; for the German school child they seem natural and easy.

What factor determines the fundamental nature of this selective process? In common with all other living organisms, the human being is a unit, in which all the structures and functions distinguished for scientific and practical purposes are confined within a single body. This body possesses the capacity to move as a unit from place to place, and maintains a physical independence from the surrounding universe by means of well-defined boundaries. Moreover, this organism is limited in time, since only one major activity can be carried on in a moment of time. The child can not, for instance, be practicing music while he is playing baseball, nor can he move toward an object which attracts him without moving away from other objects in his environment. This functional unity of the organism with respect to action enforces a selective process upon behavior, which is always with the organism. From the earliest beginnings of life, there is competition among stimuli and a conflict between patterns for dominance. Action by its very nature involves doing a particular thing at a particular time. Because our interests, as psychologists, are so strongly centered on events which occur within the organism, we often fail to take account of the fact

that the world of space and time relations sets up its own requirements to which the organism must conform, because he too is an object in a space and time world. The most essential of these requirements is that which demands that energy be applied at a specific place in order to produce modifications in the world of external relations. Selection then becomes necessary and inevitable with the result that behavior becomes specific and highly organized.

In much of our psychological thinking we are accustomed to think of abilities as determining the pattern of development. But I wonder if this is entirely correct. Should we not rather say that in an environment of multiform possibilities and of many external demands, the tasks set for human beings sort out the abilities possessed by the human organism rather than the reverse and that in many situations the task utilizes what abilities there are. There is a constant relation between the abilities which are called out by a particular environment and the resultant modification of the environment, which in turn calls upon new abilities or rearrangements in the patterns of ability. Thus in a primitive environment, the selective process operates very differently than in a highly industrialized environment. The determinants of the pattern of behavior may thus be environmental to a striking degree. This leads us to a conception of the human being as an organism of wide adaptability in which abilities are assimilated to interests and external demands. By the term demand is not meant a specific and precise task that can be described with a high degree of accuracy, though there are such, so much a system of social pressures which bear down upon the developmental pattern with increasing rigor as the child grows older.

A particular activity, interest or attitude appears. In one individual it may become like a snowball that is rolling down hill gathering unto itself a surprising number of other capacities and abilities, until a very complicated and significant behavior pattern results. In another individual, there may be no such result. Thus a young child learns to swim. It may be possible to demonstrate that a fourteen- or a ten-year-old child can learn to swim in one half or one quarter the time required by a six-year-old child. But if a six-year-old learns to swim, he may swim at every subsequent opportunity and develop a series of interests and activities which center about swimming that modify the course of subsequent development.

With increasing age the process of diverting the organism, so to speak, becomes more and more difficult, since each new activity or skill has to compete with others already established. The early acquired skill or activity not only gains by virtue of its priority, but also by virtue of its capacity to block other acquisitions.

This may be the reverse of the process described by Professor Miles last year, when he demonstrated the effect of practice in preserving abilities into senescence. Here we are concerned with the effect of practice in building activities of a high level by a process of assimilation. In either case the effect is to take the ability out of the regular course of growth, maturation and decay and give it special status.

Moreover, the nature of the environment is such that it determines the content of the demands (this is what we mean by culture) and sets up a series of social pressures which must be met. This social necessity imposes an order and system of values upon responses. In this selective process as the child passes out of infancy the demands of the environment come to have more weight than the demands of internal constitution. Soon environmental factors are determining the skills that shall be eliminated or practiced. In time these factors take precedence over basic abilities and assimilate such abilities, traits and skills to them, rather than the reverse. Hence, instead of thinking of the individual largely in terms of traits and basic capacities, as we have in the past, we might better be thinking of him in terms of interests, wants, attitudes and goals.

This brings us to a distinction between the significant and the non-significant in the environment. The significant is that which produces a modification in the developmental stream and carries the process of assimilation forward and the non-significant is that which does not affect the developmental stream. Although at the moment of stimulation both may be equal in intensity and similar in their external aspects, necessarily they must differ in the field relations within the organism. It becomes impossible, in view of the significance of this selective process, to describe the organism in terms of the stresses and strains of a moment in time. Herein lies the difficulty with Lewin's[11] skilful analysis of the dynamics of child behavior, in which the relation of the child at any moment of time to his environment is described. Little attention is paid to the internal structure of the organism which, if examined in detail, would be seen to be the resultant of many factors. Parts of this structure are definitely related to developmental levels. Parts are clearly products of past reactions to the environment, *i.e.*, the human organism is mnemonic in character and carries forward into subsequent behavior traces of earlier behavior. Parts are clearly the product of the forces and stresses inherent in the

[11] Kurt Lewin, "A Dynamic Theory of Personality." McGraw-Hill, New York. 1935.

environmental situation. We may, however, agree with Lewin that both internally and externally behavior is a relation involving fields of forces, drives and stresses, rather than a series of absolutes.

In a selective process, operating upon an organism with a very wide and fluid repertoire of behavior, is to be found the story of human development. This organism is exposed to an environment or a culture which sets up universal requirements to which all must conform in some degree and other requirements to which some must respond. It is an extraordinarily rich environment, when considered from the point of view of the range and variety of stimuli presented to the organism. In spite of the very strong and ever-present tendency forcing him toward specific behavior, the human being possesses a bodily mechanism that is extraordinarily versatile. Where many organizations of matter, both living and inanimate, are driven into narrow channels of response by the nature of selective processes to which they are exposed, the human organism preserves some capacity for reacting in almost every medium. He may not, for instance, be able to swim naturally, but he possesses arms and legs, which though specialized for walking and manipulation lend themselves to swimming. He may not be able to fly, but he possesses the ability to adapt material objects to his purposes, and extend the application of specific energy to points in a space world, so that he can build a flying machine. His hand, though it can not grasp a branch or support his weight as well as that of the chimpanzee, has an astounding range of manipulative adjustment. Man's bodily mechanism carries the greatest potentiality for generalized response with which there goes in the face of an energetic selective process the possibility within his own life of building new patterns of response of an almost infinite variety.

As the outcome of the interrelation of the organism and his environment, each individual comes to possess the quality of uniqueness. This is not accidental, but is the result of lawful forces operating throughout life. Starting with differential heredity, moving into a differential environment and subjected at all times to a differential selective process that sorts over all his capacities and skills, the human being becomes increasingly unique and different from every other of his kind. Herein lies psychological problems of great moment. We have tended too long to look upon individual behavior as a variant, rather than as the product of lawful process. In part, the variation that makes it difficult to describe and determine the laws of behavior results from the fact that every stimulus impinges in a developmental stream. Whether it becomes significant or not for later behavior depends upon the manner in which it affects that stream. Two men discovered America; one, Leif Ericson, made the more hazardous voyage and the greatest accomplishment when considered in terms of the moment, the other, Columbus, made by far the greatest accomplishment in terms of the ultimate outcome. For in the first case, there was no effect upon the developmental stream of history, in the second case the effects continued throughout centuries and will continue for many centuries more. Where developmental relations are involved, we deal mainly with lawful but nonreversible processes, *i.e.*, once a factor is introduced that affects the developmental stream, it can never be completely isolated, nor can the organism be returned to its former state. These processes are logical and meaningful when viewed from the end results. When viewed from the point of the impact of the phenomena upon the developmental stream, unless we know that stream in detail, both in its internal structure and its external relations to an environment, they do not seem so.

If this view holds, the differences between inherited and learned responses become matters of degree rather than of type, since in both the same fundamental principles are operative. In those responses appearing in prenatal life and of early infancy, the possibilities of any single system of response are distinctly limited, first because the limits within which variation occurs are narrow, and second because the environmental demand is for specific responses of a relatively low complexity. As the child grows older, the potentialities of any single system of response increase, because there is more variation within material out of which response patterns are evolved and because the level of environmental demand has shifted.

Finally we come to those complex demands of the environmental organism relation which call from the individual all the abilities he possesses, and which utilize him completely. Here we move into those final organizations of behavior in which abilities and skills are assimilated by powerful interests and needs. Here is found the realm of remote goals and ideals. Perhaps functional terms such as these are more significant and important for the understanding of human nature than many of the terms with which we have concerned ourselves. Both in the field of animal psychology and child psychology at the present time, many interesting experiments are under way which center about incentives, motivation, barriers, obstructions, pressure situations, goals, the social milieu and in the Gestalt psychology we have a theoretical formulation that is causing a thorough revision of many of our basic concepts.

The organism is coming to be viewed as a totality or a functional unit. Instead of fractionating be-

havior descriptively, we break the stimulus field up into component parts, and determine by appropriate methods the reaction of the organism to fields so broken up, reconstituted and broken up again. Interest is not in the detailed analysis of sensory phenomena as such, nor in motor phenomena as such, nor in consciousness or awareness as such, so much as in the relation of the organism to his environment, in the light of his phylogenetic and ontogenetic history. For children possess one characteristic essential for the understanding of human behavior, they are always becoming. Difficult as is the task of writing descriptions of human behavior in dynamic terms, hard as is the avoidance of those dichotomies of classification and terminology which distort the unified organism, nevertheless there are many indications that psychology is now moving rapidly away from the conception of elements of behavior as it earlier moved away from the conception of elements of sensation. A science of human dynamics lies ahead. To it the student of child behavior has much to contribute, for he studies and deals with human behavior in the making.

OBITUARY

WARREN ELMER HINDS

WARREN ELMER HINDS, who died on January 11, was born in Townsend, Massachusetts, 59 years ago. In 1899 he received the B.S. degree from Massachusetts Agricultural College, and three years later the Ph.D. degree.

After five years with the U. S. Bureau of Entomology, Dr. Hinds accepted a position with the Alabama Polytechnic Institute as professor of entomology and entomologist of the Experiment Station. After 17 years at that institution, he left Auburn and accepted a position with the Louisiana State University as entomologist for the Experiment Station and Extension Division. These positions he held until 1929, at which time he was relieved of the extension work so that his entire time could be devoted to experimental work.

Dr. Hinds's major problem in Louisiana was the control of the sugarcane borer and other insects attacking sugarcane, and among his outstanding work is the use of a native parasite to control the cane borer. The following is quoted from an editorial in the local paper:

> As an entomologist, Dr. Hinds had risen high in his profession, and had received national and international recognition. In the interest of his work, he had made trips to Peru and to Cuba, and as a delegate from the American Association of Economic Entomologists, which he has headed, he attended an important congress in Paris. Particularly in aiding boll weevil control, and in combatting sugar cane pests his efforts have been valuable here and in the South.
>
> Yet, he was admired most not for any material achievement, but for his upright character, and the kindliness and sympathy that made him beloved in his human relations. His Christian devotion manifested itself in his daily walk and conversation. Always he was to be depended upon, and to him no worthy task or contract, however small, was insignificant. He was a man who invariably did his duty. Yet, in his relations with others, he was one of the most understanding and generous of men, and in his busy life never was he too hurried for the cheerful greeting, and the kindly interest in others.

B. A. OSTERBERGER

LOUISIANA STATE UNIVERSITY

HENRY WARE CATTELL

DR. HENRY WARE CATTELL, pathologist and medical editor, died from cardiac disease in Washington on March 8 at the age of seventy-three years. He was the son of William C. Cattell, president of Lafayette College, from which institution he graduated in 1883 and of which he was later a trustee. He received the doctorate of medicine from the University of Pennsylvania in 1887 and was demonstrator under William Osler. Later he was director of the Ayer Clinic of the Pennsylvania Hospital and pathologist to Blockley, Presbyterian and other hospitals. During the war he was major, later lieutenant-colonel in the Medical Corps, having been pathologist to the Central Medical Department Laboratory and in charge of the post-mortem records of the A. E. F. He was the author of "Post-Mortem Pathology," which appeared in several editions, and the translator of Ziegler's "Special Pathological Anatomy." He was editor of Lippincott's "Medical Dictionary" and of the same publisher's "International Clinics," of which between 1900 and 1932 he edited seventy-eight volumes. Dr. Cattell was unmarried; his only near relative was his brother, Dr. J. McKeen Cattell.

SCIENTIFIC EVENTS

THE ROYAL INSTITUTION

THE bequest to the Royal Institution of Great Britain made by the late Harry Brown of the residue of his estate is expected, according to *Nature*, to amount to approximately £28,000. This sum has been given without restriction as to its use, and it is planned

to apply it mainly to the extension of experimental research.

Shortly after information as to the legacy had been received, the freehold of 19 Albemarle Street, immediately adjoining the Davy Faraday Research Laboratory and the rest of the institution's buildings, came into the market. With the double object of investing Mr. Brown's legacy and providing for future extensions of the premises, it was resolved to purchase the property. The purchase has now been completed. For the present the institution will use the top two floors of the new house for storage of books and apparatus, releasing valuable accommodation elsewhere for other purposes. It is proposed to let the lower floors, and to devote any income obtained to research purposes. Eventually, as the research activities are enlarged, it may prove necessary to occupy a larger part of the house.

Nature states that it was noticed last April that a sinking had occurred of the ceiling of the library on the first floor at the Royal Institution, and of the floor of Sir William Bragg's rooms immediately above. The ceiling, which was old and of timber construction, was found to be defective. It was temporarily propped, and at the end of the lecture season a thorough examination was made. An astonishing state of disrepair was discovered. Not only was the heavy timber ceiling defective, but also the brick walls upon which it was supported were cracked and broken in all directions. The examination was carried down to the rooms on the ground floor and here a similar state of affairs was revealed. When in 1799 the Royal Institution was founded, a large town house was purchased and considerably altered to suit its new purpose. Further alterations have been made at intervals. Vulliamy added the Corinthian column front in 1837. In 1930 a large part of the building, including the lecture theater, was completely reconstructed, but the library and rooms below it were left untouched. These it has now proved necessary to rebuild.

The reconstruction is now in progress. The defective brickwork of the walls is being replaced, including that of the front wall, which is being worked at from the inside, so that the elevation of Albemarle Street will remain untouched. New fire-resisting floors are to be supported on a steel structure, which is being erected within the walls. The steel work, the foundations for which are being carried to basement level, will also serve to strengthen the rebuilt walls. When completed, the rooms on the first and second floors will appear much as they were before, but advantage is being taken of the alterations to construct a large new research laboratory in the basement. The work is expected to be completed in April, and it is understood that it will cost about £12,000.

THE FIRST MEETING OF THE PHYTOPATHOLOGISTS OF BRAZIL

THE result of preliminary conversations during several years, and of the activity of an organizing committee, consisting of H. S. V. Grillo, chief of the Section of Plant Pathology of the Instituto de Biologia Vegetal of the Ministry of Agriculture; A. S. Müller, professor of plant pathology of the Escola Superior de Agricultura do Estado de Minas Geraes, and N. Azevedo, of the same institute, the first reunion of phytopathologists of Brazil was held in Rio de Janeiro from January 20 to 25, 1936.

The inaugural session was presided over by the Minister of Agriculture, Dr. Odilon Braga, who installed as president of the reunion Dr. A. A. Bitancourt, sub-director of the Instituto Biologico de São Paulo, elected in preparatory session by the members of the reunion.

The daily program of the meeting consisted in excursions at 9:00, special sessions at 3:00 and general sessions opened to the public at 5:00, held in the library of the historical Jardin Botanico of Rio.

Papers were presented on the history of phytopathology in Brazil, the need for the development of phytopathology in Brazil, the teaching of phytopathology in Brazil, the organization of plant protection in various countries, fungus flora in Brazil, quarantines, spraying machinery, as well as various papers on fungicides, specific plant disease problems and related subjects.

Through the cooperation of Dr. J. Campos Porto, director of the Instituto de Biologia Vegetal do Rio, a special number of the official journal of the institute, *Rodriguesia,* will be dedicated to the proceedings of the meetings, and will contain the titles and abstracts of these papers or entire papers when short.

A special committee was selected to serve during the year 1936, for the study of the projects and suggestions which appeared, relative to phytopathological nomenclature, plant disease surveys, plant protection legislation, future meetings and the formation of a society. The members are A. A. Bitancourt, H. S. V. Grillo, A. S. Müller, H. P. Krug and N. Fagundes.

A social gathering was held one afternoon at the home of the director of the institute, within the Botanical Gardens, in the form of a tea, offered by the Minister of Agriculture.

ALBERT S. MÜLLER,
Acting Secretary

WORK OF THE COMMITTEE ON UNEMPLOYMENT AND RELIEF FOR CHEMISTS AND CHEMICAL ENGINEERS

THE Committee on Unemployment and Relief for Chemists and Chemical Engineers, also known as Chem-

ists' Unemployment Committee, was formed in the winter of 1931 and began to function actively in the early part of 1932. It is sponsored by the following technical societies in the Greater Metropolitan area: American Chemical Society (New York and North Jersey Sections), American Gas Association, American Institute of Chemical Engineers, American Institute of Chemists, Association of Consulting Chemists and Chemical Engineers, Inc., Association of Municipal Chemists of the City of New York, Compressed Gas Manufacturers Association, Electrochemical Society, Société de Chimie Industrielle (American Section), Society of Chemical Industry (American Section), Technical Association of Pulp and Paper Industry and the Chemists' Club.

It is acting under the guidance and advice of representatives of the above societies, together with leaders in the chemical profession:

First: The committee aims to do what it can to provide positions for those unemployed qualified applicants who register with it. Positions will in general be one of the following classes: Chemical work, either temporary or permanent; temporary non-chemical work, and temporary relief work.

Second: The committee tries to secure a proportionate share of city, state and federal funds devoted to unemployed relief and make them available for qualified registrants or suggest useful chemical projects which these agencies may authorize.

Third: The committee undertakes to raise funds to carry on this work and to supplement them with the assistance that can be obtained from other organizations.

When the committee began its work in 1931, it was faced with an unusual number of those in dire need and distress. Due to the limited funds available at its disposal, it had to seek assistance from organizations financed by public funds, such as the Gibson Committee, Bliss Committee, etc., and when these organizations went out of existence, it sought help from city, state and federal bureaus which took over the work. Due to the assistance received from these agencies, supplemented by the funds contributed by the profession, the committee has successfully eliminated destitution and distress among those registered.

The circumstances of those on the present active file, as determined from our November 1, 1935, canvass, show that more than two hundred are willing to accept any useful work, such as jobs on WPA projects, technical or non-technical jobs, but none is willing to go through the routine established by the Home Relief Bureau. However, there are a few cases still applying for financial aid, which is given in the form of "made-work," loans, food, clothing, etc.

The committee's work is financed from funds contributed by individuals in the profession. Since 1932 1,278 donors have responded to calls for help. Thirty-nine companies voluntarily contributed. Chemists and chemical engineers employed in sixteen laboratories, representing 199 persons, sent in group contributions from their respective laboratories. A total sum of $47,210 has been received as a result of these appeals. Through the courtesy of prominent chemical companies, office space and equipment needed for the office have been donated. The advisory and executive bodies have given their services without compensation. In expending the funds contributed the committee observes the strictest economy in its routine.

PRESENTATION OF THE WILLIAM H. NICHOLS MEDAL TO DR. CLARK

FOR researches "of incalculable value to human welfare" the William H. Nichols Medal of the New York Section of the American Chemical Society for 1936 was presented on March 6 to Dr. William Mansfield Clark, Delmar professor of physiological chemistry in the Johns Hopkins School of Medicine, at a dinner given by the section at the Hotel Pennsylvania.

Professor A. Baird Hastings, of the Harvard University Medical School, in describing Dr. Clark's work said:

> The investigation of the problems of oxidation and reduction, involving balances in the exchange of electrons, or electrons and protons, between substances, are being prosecuted with profit in all fields of science and industry. Wherever such investigations are under way, the contributions of Dr. Clark and his collaborators constitute the foundation of the work.
>
> In a series of classic papers Dr. Clark clearly developed the meaning of pH, its place in biological problems, and a description of accurate methods for its determination. He reported in detail the preparation and characteristics of that beautiful series of acid-base indicators which are to be found in almost every laboratory the world over.
>
> His scientific studies have found their way into the hands of bacteriologists, biological chemists, analytical chemists, physiologists, pathologists, pharmacologists, clinicians and engineers, to name but a few. His work has found its uses in the leather, the bread, the brewing, the paper, the sugar, the cement, the rubber and the dairy industries, and countless other fields of scientific activity.

Professor A. W. Hixson, of Columbia University, chairman of the Nichols Medal Jury of Award, presented the medal to Dr. Clark. Dr. Donald D. Van Slyke, of the Rockefeller Institute, spoke on "The Medalist's Personal Career." Dr. Lawrence W. Bass, of the Borden Company, chairman of the New York section, presided. Professor Clark's medal address was entitled, "A Little of the Perspective of Acid-Base and Oxidation-Reduction Equilibria."

Professor Clark is a member of the editorial board of *The Journal of Biological Chemistry,* president of

the Johns Hopkins Medical Society, and non-resident vice-president of the Washington Academy of Sciences. He is a member of the National Academy of Sciences, Phi Beta Kappa and Sigma Xi, a fellow of the American Association for the Advancement of Science and a past president of the Society of American Bacteriologists and the American Society of Biological Chemists. He has served as chairman of the Washington and Maryland Sections of the American Chemical Society. He is a member of the Cosmos Club of Washington.

The Nichols Medal, on original research in chemistry, was established in 1903 by the late Dr. William H. Nichols, who was chairman of the Board of the Allied Chemical and Dye Corporation.

Previous recipients of the medal have been Irving Langmuir, General Electric Company; James Bryant Conant, president of Harvard University; Roger Adams, University of Illinois; Thomas Midgley, Jr., vice-president, Ethyl Gasoline Corporation; Samuel Colville Lind, University of Minnesota; Edward Curtis Franklin, Stanford University; Charles A. Kraus, Brown University; Henry C. Sherman, Columbia University; Samuel Edward Sheppard, Eastman Kodak Company; John A. Wilson, Milwaukee, Wis., and Father Julius A. Nieuwland, Notre Dame University.

Members of the 1936 Jury of Award, in addition to Professor Hixson, are Dr. D. P. Morgan, of Scudder, Stevens and Clark; Professor Victor K. LaMer, of Columbia University; Dr. Walter S. Landis, vice-president of the American Cyanamid Company, and Dr. J. M. Weiss, of Weiss and Downs.

SCIENTIFIC NOTES AND NEWS

DR. RUDOLPH MATAS, professor emeritus of surgery at the Medical School of Tulane University, has been elected president of the International Congress of Surgeons and will preside at the 1938 congress in Vienna, which will probably be held during the summer.

THE International Society of the History of Medicine, which held its tenth congress at Madrid last fall, has elected the following officers for the next triennium: *Founder-President,* Tricot-Royer (Antwerp); *Honorary President,* Giordano (Venice); *Active President,* Gomoiu (Bucharest); *Vice-presidents,* Singer (London), de Lint (Leyden), Capparoni (Rome), Laignel-Lavastine (Paris), Diepgen (Berlin); *Secretary General,* Guiart (Lyons); *Assistant Secretary,* Van Schevensteen (Antwerp); *Archivist,* Fosseyeux (Paris); *Treasurer,* Boulanger-Dausse (Paris). The eleventh congress will be held in September, 1938, at Athens, Istanbul, Sophia and Zagreb. The chief subjects for discussion will be the religious origins of Hippocratic medicine; the Hippocratic idea in modern medicine, and medical folklore.

A. M. MACCUTCHEON, engineering vice-president of the Reliance Electric and Engineering Company, at Cleveland, Ohio, has been nominated to the presidency of the American Institute of Electrical Engineers.

AT the twenty-third recent annual meeting in New York City of the American Society for the Control of Cancer, the new officers elected were Dr. Robert B. Greenough, of Boston, *president;* Dr. E. B. Wilson, of Boston, *vice-president;* Dr. Frank E. Adair, of New York, *secretary,* and Calvert Brewer, of New York, *treasurer.* Dr. James Ewing, of New York, was elected chairman of the board.

A DINNER in honor of Dr. Moses Gomberg, professor of organic chemistry and head of the department at the University of Michigan, was tendered to him on February 8. Dr. Gomberg, now seventy years of age, retired from active teaching recently, after having been a member of the faculty since 1893. A bound volume of birthday greetings was presented to him together with a framed portrait, by Phi Lambda Epsilon, honorary chemistry society, and a scholarship fund of $5,000, to be known as the Gomberg scholarship fund, will be turned over to the university. A. H. White and E. C. Sullivan spoke for his old associates in studying and teaching. F. W. Sullivan, Jr., as toastmaster, read the numerous telegrams of good wishes that came from institutions and individuals throughout the country and from Europe. In accordance with the wish of Dr. Gomberg the scholarship fund will be used for promising undergraduate students who are in need of financial assistance.

A TESTIMONIAL dinner was recently given in honor of Dr. Huntington Williams, health commissioner of Baltimore, by more than 200 Baltimore physicians and officers of the Baltimore Association of Commerce. Dr. John M. T. Finney, professor emeritus of surgery of the Johns Hopkins University School of Medicine, was toastmaster. Speakers at the dinner included Mayor Jackson, Drs. Thomas S. Cullen, who was honorary chairman; Charles C. W. Judd, Allen W. Freeman, Baltimore, and Reginald M. Atwater, New York, secretary of the American Public Health Association. Dr. Williams has been commissioner of health of Baltimore since 1932, when he succeeded the late Dr. C. Hampson Jones. He resigned as secretary of the New York State Department of Health, Albany, to become director of health of Baltimore.

THE Danish Academy of Science has awarded to Henry B. Collins, of the National Museum in Washington, a gold medal and $200 for a treatise on the origins of Eskimo culture.

DR. EUGENE M. LANDIS, of the Medical School of the University of Pennsylvania, has been awarded the John Phillips Memorial Medal of the American College of Physicians for his work on the passage of fluid through the capillaries.

Nature reports that Dr. C. V. Drysdale, director of scientific research for the British Admiralty in 1929–34, has been awarded the thirteenth Duddell Medal of the Physical Society for his work in connection with electrical and optical instruments.

SIR THOMAS BARLOW was elected on February 4 a foreign associate member of the French Academy of Medicine.

AT his own request, Professor H. V. Wilson has been relieved of administrative duties in the department of zoology of the University of North Carolina after thirty-one years of service. Professor Wilson continues in full-time teaching. Professor R. E. Coker, who is also chairman of the division of the natural sciences in the College of Arts and Sciences, has succeeded him as head of the department.

DR. ALVIN R. CAHN, of Ely, Minn., has been appointed chief of the Fish, Game and Wild Life Unit of the Forestry Division in the Tennessee Valley Authority, with headquarters at Knoxville. Dr. Cahn was for twelve years on the faculty of the department of zoology at the University of Illinois, but last semester resigned his position as assistant professor to take effect on March 1. Dr. Cahn has traveled extensively in the wilderness areas of the United States and Canada and has made ecological studies along the coast and islands of Norway and Lapland.

PROFESSOR FRANK B. HOWE, of the department of agronomy of the New York State College at Ithaca, until recently head of the State Soil Conservation Service, has been named head of a technical advisory committee sponsored by the State Planning Commission to further a coordinated program of soil conservation and flood control.

DR. B. L. WADE, of the U. S. Department of Agriculture, who has been stationed at the Davis Branch of the College of Agriculture of the University of California, has been called to Charleston, S. C., to take charge of the federal vegetable breeding station there. The station was established by vote of the directors of the agriculture experiment stations in eleven southeastern states.

PROFESSOR H. HOAGLAND, director of the biological laboratories of Clark University, has been appointed consultant in physiology at the Worcester State Hospital.

LAUREN B. HITCHCOCK has resigned as professor in charge of the course in chemical engineering at the University of Virginia to join the Hooker Electrochemical Company as consulting chemical engineer.

ROBERT L. JONES, formerly director of the insulin laboratories of Frederick Stearns and Company, and more recently with the Research Laboratory of the Children's Fund of Michigan, has joined the research staff of the Abbott Laboratories at North Chicago, where his work will be concerned with problems in biochemistry.

GEORGE J. BURKHARDT, a recent graduate of the University of Wisconsin, has been appointed associate agricultural engineer at the Puerto Rico Experiment Station of the United States Department of Agriculture. He will be engaged in studies for the farm and industrial utilization of different species of bamboo. Dr. James H. Jensen, formerly assistant pathologist at the Rockefeller Institute for Medical Research at Princeton, has been appointed plant pathologist for the station.

MYRON WEISS, associate editor of *Time*, has been elected a member of the American Society for Metals. He has assumed the newly created post of advisory editor to *Metal Progress*.

LOVETT GARCEAU, formerly (1931–1935) in charge of the development of electrophysiological apparatus in the department of physiology at the Harvard Medical School, has left in order to establish a private laboratory in Diamond Hill, R. I. He is now engaged in the development and manufacture of electrical apparatus for the medical profession and in scientific research.

DR. HERBERT J. SPINDEN, curator of primitive art at the Brooklyn Museum, left on March 10 for Nicaragua in an effort to determine the origin of the ancient Chorotegan tribes and collect articles made by the Mosquito and Suma Indians who inhabit the little-known forest land southwest of Matagalpa.

DR. ERWIN STRESEMANN, curator of birds at the Zoological Museum of Berlin, is visiting the United States and is making a series of studies of methods employed by leading American museums.

DR. WALTER B. CANNON, George Higginson professor of physiology at the Harvard Medical School, Boston, delivered the first Leo Loeb Lecture at Washington University School of Medicine on March 2. His address was entitled "Some Adventures in Discovery."

DR. ALEXIS CARREL, member of the Rockefeller Institute for Medical Research, will deliver the sixty-eighth Charter Day address at the University of California at Los Angeles on March 20. The address will be followed in the evening with a dinner honoring Dr. Carrel, tendered by the University Associates.

THE sixth Harvey Society Lecture by Dr. Richard E. Shope will be given at the New York Academy of Medicine on March 19. It was not given on March 10, as erroneously reported in a recent issue of SCIENCE.

DR. CHARLES C. COLBY, professor of geography at the University of Chicago, recently gave six lectures on "Science in Regional Planning" before the Senior Research Group of the Tennessee Valley Authority at Knoxville.

DR. THOMAS C. POULTER, of Iowa Wesleyan College, and second in command of the Second Byrd Antarctic Expedition, delivered a series of addresses at Iowa State College, concerning the experiences and results of that expedition, from February 10 to 13.

DR. GERHARD SCHMIDT, of the department of chemistry of Queen's University, Kingston, Canada, gave a lecture on March 2 before the Physiological Society of the University of Toronto. The subject was "The Importance of Linkage and Prosthetic Groups in Relation to Enzyme Action." Dr. Schmidt was formerly in the University of Frankfurt a. Main.

SIR WILLIAM BRAGG, president of the Royal Society, opened the Very Low Temperatures Exhibition in the lecture theater of the Science Museum, South Kensington, on March 4. The chair was taken by Sir Henry Lyons.

THE Midwestern Psychological Association will hold its annual meeting at Northwestern University, on April 24 and 25, under the presidency of Dr. Christian A. Ruckmick, of the State University of Iowa. The title of Dr. Ruckmick's presidential address will be "Psychology To-morrow."

THE sixty-sixth annual meeting of the Wisconsin Academy of Sciences, Arts and Letters will be held at the University of Wisconsin on April 17 and 18. Dr. Rufus Mather Bagg, professor of geology emeritus of Lawrence College, will give the address of the retiring president on Friday afternoon, on "Geologic Contributions to Human Progress." The annual dinner will be held in the evening, after which Dr. Glenn Frank, president of the University of Wisconsin, will make an address.

THE twenty-fourth annual meeting of the Eugenics Research Association will be held at the American Museum of Natural History, New York City, on June 6. It is requested that all persons who have papers to present indicate their tentative intentions by an early letter to the secretary. Papers will be limited to twenty minutes and must be presented in person. Lantern, blackboard, chart, wall and exhibit space will be provided at the meeting. The paper itself, with a two hundred fifty word abstract, must be forwarded to the secretary of the Eugenics Research Association, Cold Spring Harbor, L. I., New York, not later than May 6.

THE annual meeting of the Cyrus M. Warren Committee of the American Academy of Arts and Sciences will be held in May to consider applications for grants. The awards, in any case, do not exceed $500 and are limited to the field of chemistry. Applications for grants should be sent to the chairman of the committee, Professor James F. Norris, Massachusetts Institute of Technology, Cambridge, Mass., before May 1.

APPLICATIONS must be on file with the U. S. Civil Service Commission at Washington, D. C., not later than March 23 for the positions of principal agricultural research writer, at a salary of $5,600 a year; special agricultural research writer, at a salary of $3,800 a year; agricultural research writer, at a salary of $2,900 a year; agricultural research writer (radio), at a salary of $2,900 a year. Vacancies in these positions in Washington, D. C., and in the field, and in positions requiring similar qualifications will be filled from these examinations, unless it is found in the interest of the service to fill any vacancy by reinstatement, transfer or promotion. The salaries named above are subject to a deduction of 3½ per cent. toward a retirement annuity.

THE eighth Smithsonian anthropological and archeological expedition to Alaska, under Dr. Aleš Hrdlička, will leave Seattle on May 16. The initial excavations, as during the two preceding seasons, will be on Kodiak Island, but at the end of June the party will leave on a U. S. Coast Guard boat for some of the western Aleutians. As on his previous trips, Dr. Hrdlička will be accompanied by a small party of volunteer college students who with him will carry on the excavations. These students receive, aside from such field training as may be possible, a course of lectures on the human skull and skeleton, on general anthropology and on the principles of American archeology. No charge is made for this instruction, but the students must pay their own expenses. Due to the limited accommodations the number of students for the coming season must be limited to six. Applications should be made to Dr. A. Hrdlička, U. S. National Museum, Washington, D. C.

A CORRESPONDENT writes: Clellan S. Ford, Bishop

Museum fellow in Yale University, returned to Honolulu on February 7 from ethnological field work on the island of Naviti, the geographical and political center of the Yasawa archipelago, western Fiji. His preliminary survey of all islands in the archipelago indicates that the material culture of Yasawa is homogeneous. The extensive use of pottery suggests similarity with the Lau Islands, where Melanesian and Polynesian influences are intermingled, but contrasts with neighboring Samoa and Tonga, where the culture is purely Polynesian.

NOMINATIONS to the Council of the American Association of Museums for the three-year term 1936–39 have been made as follows: Andrey Avinoff, director, Carnegie Museum, Pittsburgh; Alfred H. Barr, Jr., director, Museum of Modern Art, New York; Kenneth Chorley, vice-president, Colonial Williamsburg, Incorporated, Williamsburg, Va.; O. T. Kreusser, director, Museum of Science and Industry, Chicago; Arthur C. Parker, director, Rochester Museum of Arts and Sciences; Edward K. Putnam, director, Davenport Public Museum; Mrs. John D. Rockefeller, Jr., trustee, Museum of Modern Art; Paul J. Sachs, associate director, Fogg Art Museum, Harvard University, Cambridge; George H. Sherwood, honorary director and curator-in-chief of education, American Museum of Natural History, New York, and Alexander Wetmore, assistant secretary, Smithsonian Institution, in charge of U. S. National Museum, Washington.

AT the February meeting in Chicago of the American Medical Association the following were elected to fill vacancies caused by expiration of terms, resignations and deaths: *Council on Pharmacy and Chemistry,* Dr. Torald Sollmann to succeed himself; Dr. W. C. Rose, Urbana, Ill., to succeed Dr. Lafayette B. Mendel (deceased), and Dr. E. M. K. Geiling, Baltimore, to succeed Dr. Reid Hunt (resigned). No appointment was made to fill Dr. L. G. Rowntree's place at present, it being decided that the work of the council could be conducted with one less member. *Council on Physical Therapy,* Drs. Robert B. Osgood, F. J. Gaenslen and Howard T. Karsner to succeed themselves. *Committee on Foods,* Dr. Russell M. Wilder to succeed himself, and Dr. Martha Eliot, New Haven, to succeed Dr. Lafayette B. Mendel (deceased). To expedite work of this committee, it was decided to make its secretary a member of the committee. *Archives of Internal Medicine,* Dr. Arthur Bloomfield; *Archives of Ophthalmology,* Dr. Arnold Knapp; *Archives of Neurology and Psychiatry,* Dr. H. Douglas Singer; *Archives of Otolaryngology,* Dr. Ralph A. Fenton; *Archives of Pathology,* Dr. Frank R. Menne, all to succeed themselves. *Archives of Dermatology and Syphilology,* Dr. Howard Fox, of New York, to succeed Dr. Charles J. White. *Archives of Surgery,* Dr. William Darrach, to succeed himself, and Dr. Waltman Walters, Rochester, Minn., to succeed Dr. E. Starr Judd (deceased). *Committee for the Protection of Medical Research,* Drs. Lewis H. Weed and Dr. Walter B. Cannon to succeed themselves. *Committee on Scientific Research,* Dr. Ludvig Hektoen to succeed himself. The resignation of Dr. Victor C. Jacobsen from the editorial board of the *Archives of Pathology* was received and it was decided not to fill his place.

AIR HYGIENE FOUNDATION OF AMERICA, INC., has been formed by a group representing various industries, with headquarters at Thackeray Avenue and O'Hara Street, Pittsburgh, Pa. The purposes of this organization are to conduct investigations of and to stimulate research on problems in the field of air hygiene and to gather and disseminate factual information relating thereto. It will also cooperate with and assist other agencies active in this field and will collaborate in the coordination of such research efforts. A comprehensive investigation has been begun at Mellon Institute of Industrial Research, Pittsburgh, under support of Air Hygiene Foundation of America, in which the hygienic, technologic and economic aspects of air contamination, especially by dust in the industries, will be studied.

A MEETING of the British Academic Assistance Council, under the presidency of Lord Rutherford, was held in London on February 21 in the rooms of the Royal Society. The gift of two research fellowships of the annual value of £450 each was announced. After consultation with the Royal Society, the council awarded one fellowship for a period of three years to Dr. Walter Heitler, to enable him to continue his research in theoretical physics at the University of Bristol. From its general funds the council awarded a fellowship for three years to Dr. Veit Valentin, to enable him to continue his work in German history at University College, London. Dr. Walter Heitler, formerly of the University of Göttingen, is best known for his work connected with the quantum theory of valency and more recently in connection with the theory of absorption of particles and radiation of high energy. Dr. Veit Valentin is regarded as the leading authority on the German Revolution of 1848. He was head archivist, and director of the research department for the history of culture of the German State Archives, at Potsdam. It was reported that the dismissal of university teachers in Germany on account of opinion or race was still continuing, and that even after dismissal scholars were denied access to libraries and forbidden to accept invitations from

universities and learned societies abroad. The officers also reported that six university teachers had been dismissed in Portugal for other than professional reasons. The council decided that there was continuing need for a non-political organization to assist displaced scholars and scientific men, and made plans for the creation of a more permanent body, a Society for the Protection of Science and Learning, to take over its activities. An invitation to join this society will shortly be issued.

DISCUSSION

CORTICAL EXCITATORY STATE AND VARIABILITY IN HUMAN BRAIN RHYTHMS

IN a recent communication to this journal entitled "Temperature Characteristics of the 'Berger Rhythm' in Man" Hudson Hoagland[1] has described experiments which appear to show three temperature characteristics in general paresis patients. We have found in similar experiments on both normal and convulsive (*petit mal*) cases temperature characteristics for both the occipital alpha rhythm (wrongly called the "Berger Rhythm") and the central beta rhythm which were of the same order of magnitude as the lowest of the values reported by Hoagland (7,000 to 8,000 calories). Our control experiments without a temperature change, however, have shown repeatedly frequency changes of the same order of magnitude (1 to 2 cycles per sec.) during the course of one or two hours experimentation. It appears to us that, in the absence of such controls in Hoagland's report and since our experiments indicate a higher variability in some pathological brain conditions, we should suspend judgment in regard to the underlying physicochemical processes controlling these rhythmic activities as determined by apparent temperature characteristics alone in pathological cases.

The cause of variability in the bioelectric activity of the human brain is extremely complex. Some of this complexity may be shown by the following observations: (1) The frequency of the occipital alpha rhythm may be decreased during drowsiness and increased following arousal by an adequate stimulus. (2) Adequate sensory stimulation may diminish or abolish rhythmic activity in a waking person, while the same stimulus may cause bursts of activity to occur in the sleeping person. (2) Sleep itself causes a complex series of changes, involving first a slowing of the rhythmic activity with accompanying changes in amplitude and regularity and then the rhythmic activity being replaced by a predominance of large, irregular, random, usually slow, potential swings, with occasional bursts of rhythmic activity at frequencies of 3 to 6 or 7 per sec. more marked in the occipital region (probably the slow alpha process) and bursts of 12 to 14 cycle rhythm more marked in the central region (probably the slow beta process). (4) Some individuals, upon first examination, appear to show no regular rhythmic activity from any region; the record appearing similar to that obtained after existing rhythmic activity is broken up by sensory stimulation in other individuals. Some of these individuals will show good regular rhythms if they are placed in a sound-proof room and allowed sufficient time for general relaxation or are relieved of some tension or worry. A more or less sustained state of cortical excitation seems to be involved in this absence of rhythmic activity. (5) Frequency changes due to temperature are present but complicated by the variable increase in general excitability in the febrile condition plus associated circulatory changes. (6) States of excitation involving the autonomic nervous system, such as fear, anxiety and worry, affect markedly the frequency and regularity of brain rhythms. (7) The first five or ten beats of the occipital alpha rhythm as it recovers from being abolished by light stimulation are at a higher frequency than those in a period ten or fifteen seconds later. As the rhythmic activity builds up it appears to decrease progressively in frequency (*e.g.*, in one case from about 11 to 9.5 per second). It is as though some sustained effect of the afferent impulses, which might be called the cortical excitatory state, was increased above the level which permits rhythmic activity and then decreases, following the cessation of the stimulus to a level permitting rhythmic activity at first rapidly and then with decreasing frequency until it passes to a lower more constant level.

The rhythmic discharge of a relaxation oscillator as controlled by variations in its driving potential may be an excellent analogy for the control of the rhythmic discharge of cortical cells by the variation in cortical excitatory state. The gas discharge tube in such an oscillator will function rhythmically only when the applied potential is within certain limits (depending upon the time constant of the circuit RC and the tube characteristics). As the applied potential is increased from zero a level may be reached which will cause the tube to discharge in a random manner with occasional regular discharges at a low frequency (as for brain potentials during sleep) and then the frequency of

[1] H. Hoagland, SCIENCE, 83: 84–85, 1936.

regular discharge will be increased with an increase in applied potential up to a limit above which a further increase in potential will cause a constant discharge with little or no rhythmic activity. The appearance of rhythmic activity following stimulation during sleep is explained by assuming a low level of cortical excitatory state during sleep which is brought up to a level permitting rhythmic activity. The level of cortical excitatory state may be already up to such a level in the waking state that a further increase with stimulation causes the excitatory state to pass beyond the level permitting rhythmic activity, perhaps, into the region of constant discharge. Furthermore, it appears as a general rule that the amplitude of brain potentials decreases with their frequency, which occurs also in the relaxation oscillator of proper RC constants.

Variations in the bioelectric activity of brain cells could be due to (1) changes in physico-chemical processes within the cells, such as accompany toxic agents, circulatory changes, temperature, etc.; (2) differences in the physical structure of the cell, as in normal cyto-architectonic structure and pathological cell growth, and (3) changes in the anatomical and function association of one group of cells with another. All these factors, plus the specific effect of centripetal nerve impulses themselves, may affect the cortical excitatory state, which may be considered a major factor in controlling rhythmic activity.

HERBERT H. JASPER

BROWN UNIVERSITY AND
THE EMMA PENDLETON BRADLEY HOME

THE MOISTURE RELATIONS OF PECAN LEAVES

IT has frequently been noted by those familiar with the growth of pecan trees that under orchard and field conditions pecan leaves do not wilt. In periods of drouth leaves lose their "freshness" but do not actually wilt. As the drouth period progresses little change occurs in the appearance of the leaves until seemingly when a critical point in moisture deficit arrives. Then a "drouth necrosis" of sharply marginated areas of the leaflets occurs. This is frequently followed by an abscission of leaflets and leaves. Recently, data have been obtained which may have a bearing upon this phenomena and upon the relation of soil moisture to leaf functioning and to the formation and accumulation of storage carbohydrates in the tree.

In endeavoring to influence the vegetativeness of trees, their carbohydrate storage and the "filling" and maturity of nuts at harvest time, plots varying widely in soil moisture content have been maintained. In the wet plots soil moisture approaches field capacity; in the dry plots moisture is below the wilting point in the first two feet and below optimum at lower depths. Leaves in the drier plots are smaller, thicker, less green and lacking in "freshness." A typical margined "drouth necrosis" of many leaves has occurred, but there has been no wilting. It was presumed that the moisture content of leaves from the wet and dry plots would be significantly different. We have been surprised to find, from many determinations, that the per cent. of moisture in mature leaves is nearly constant, regardless of differences in soil moisture when conditions for maximum transpiration obtain; *i.e.*, between the hours of one and five P.M. on days of maximum brilliance, high temperature and low humidity. During the night or on cloudy and humid days, the moisture content of leaves increases slightly and the increase is greatest in leaves from the wet plots. Subsequent investigations have included trees growing in commercial orchards with highly variable soil moisture.

Using the familiar cobalt chloride method the transpiration of leaves in the wet and dry plots has been studied. No attempt has been made to measure the relative rate of transpiration in the two. However, leaves which show any appreciable drouth necrosis transpire very slowly, if at all, but healthy leaves under wide extremes of soil moisture transpire freely. Apparently a considerable degree of drouth may occur before transpiration ceases or before CO_2 entrance into the leaf and the interruption of photosynthetic processes occurs. This latter has been best shown by microscopic studies which clearly reveal a greater amount of starch and hemicellulose cell wall thickenings in shoots from the dry than from the wet plots. Conversely, the nitrogen content in leaves and other tissues is reduced in the dry plots.

With a reduced nitrogen content and with photosynthetic action but slightly if at all impaired conditions favoring carbohydrate storage are accomplished through moderate drying of the soil. It is suggested that in soil moisture control may lie an important means for regulating the formation and utilization of carbohydrate reserves in the tree. These latter are believed to be of prime importance in that in late summer they are probably converted to sugars, fats and oils and hence influence the filling and quality of nuts at harvest.

ALTON H. FINCH
CLIFTON W. VAN HORN

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THE "FLIGHT" OF FLYING FISH

IN a recent article in SCIENCE (83: 80, 1936), C. A. Mills discusses the propulsive power used by flying fish. As a Naval Reserve officer I have, during the last twelve years, spent many hours at sea on various naval

vessels, mostly destroyers, in the waters of Southern California, where the flying fish *Cypseturus Californicus* abounds. In view of the controversial nature of the supposed "flight" of these fish, I have repeatedly and carefully observed their movements from the advantageously low position afforded by smaller craft. I have also observed them at night under strong lights when netting or spearing them at the ship's gangway for the mess.

It appears quite certain from my observations that the chief impetus for the flight is derived under water, apparently the major portion of the thrust coming from tail movements. When swimming under the light the pectoral fins are little used and mostly folded. Occasionally, when apparently stupefied by the light the fish lie with both pectoral fins half spread in a peculiarly relaxed position. Under the light I have never observed any active use of the pectoral fins in swimming. A single powerful thrust may be given in folding the fins from the open position at rest. In daylight flights as the fish leaves the water, in most but not all cases, as stated by Mills, its wings *appear to move* as if in an effort to fly. The motion is not long continued, only four to six or at most about 20 vibrations being accomplished. While such fin movements are in the nature of flying movements the fins are awkwardly handled and seem woefully inefficient and inadequate when compared to the motion of the wings of birds in flight. The wing motions are more in the nature of the bat's wing action, but vastly slower and of relatively small amplitude. It is my distinct impression that these apparent flying motions are in part a consequence of the body motions in swimming which are sustained after emergence from the water and must be readjusted in adapting their movements to the new medium. There is no question but that a large part of the effective effort of this wing motion is expended in orienting the body and wings for the soaring flight which comprises 95 per cent. of the distance covered. It is not used in gaining altitude. There is also a possibility that the motions serve the purpose of disencumbering the fins of superfluous water in taking to the air. Doubtless the motion accomplishes several purposes at the same time, but it is very doubtful whether any momentum for the flight is gained in this way. Once the wind has been caught and the body oriented the flight is definitely a soaring flight with not the least indication of wing movement. This portion of the flight is much like that of the paper darts used by school boys, with, however, some steering action by wings and tail. The flight continues until the fish recovers from its alarm or until, owing to an improper start, it loses altitude. If the flight is to be resumed the fish, as it approaches the water, lowers its tail and with a series of powerful and rapid strokes of the tail in the water regains enough momentum for a continued flight. The motion of its pectoral fins is usually negligible or entirely missing in this new flight. In some cases the fish has been observed to renew its flight in this fashion three times after its initial "take off." The end of the flight is quite abrupt, the tail drops to act as a brake, and the wings fold as the fish strikes the water. The splash produced is confined to the body impact with the water. The flights appear to be conditioned by disturbances in the water, *i.e.*, the bow or hull of the ship or the ship's bow wave. The "take off" under water thus must be in a direction away from the position from which the disturbance comes. In most cases the flight therefore starts along lines radiating from the bow of the ship or at right angles to the hull. On emergence the direction of flight appears to be determined largely by the wind direction and the initial impulse, the latter being away from the disturbing agent. Since the flight is largely dependent on the wind it is clear that successful flights will be controlled by this factor. If the "take-off" occurs under unfavorable circumstances the flight terminates abruptly. Flights originating on the starboard bow have been observed occasionally to cross the bow and end well off the port bow and *vice versa* under proper wind conditions.

LEONARD B. LOEB
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FLYING FISH

THE recent article by Dr. C. A. Mills on "The Source of Propulsive Power Used by Flying Fish"[1] gives an interesting description of the method of regaining lost flying speed by dipping the tail into the water and lashing with it to attain the velocity for a fresh take-off. Having read of this maneuver, and observed it a number of times, I was surprised at the implication that this feature of the flight is not recognized in the literature of the subject.

In January, 1934, I made the voyage from Woods Hole to Panama on the oceanographic ship, *Atlantis*, in company with C. M. Breder, of the New York Aquarium, and other investigators. Mr. Breder had with him a large assortment of literature on flying fish[2] in which I read of the performance that is described by Dr. Mills. After the initial take-off, the fish glides till flying speed is lost, then dips his tail in the water and sculls with it till flying speed is again

[1] SCIENCE, 83: 80, 1936.

[2] R. E. Dowd, *Aerial Age Weekly*, January 10, 1921, pp. 464–465. W. E. Shoulejkin, *Int. Rev. d. ges. Hydrobiol. u. Hydrographie*, 22: 102–110, 1929. C. M. Breder, Jr., *Copeia*, 4: 114–121, 1930. C. L. Hubbs, *Papers Mich. Acad. Sci., Arts and Letters*, 17: 575–611, 1933; (see also, *Ann. Rept. Smithsonian Institut. for 1933*: 333–347, 1935).

attained. I believe it was generally stated in the papers which I read that two or three such renewals are usual before the fish concludes his flight and submerges.

Instigated by Mr. Breder, I timed several flights with a stop watch, observing from the bow of the boat, but, though I witnessed several of these transient contacts with the water, my position was not high enough to permit a very clear view of the procedure. My best chance to observe the performance clearly was on my return to the north, when flying over the Caribbean Sea in a Pan-American amphibian plane near the island of Cozumel. It was on February 19. The plane was flying nearly into a light southwest wind at about 1,000 feet above the sea. Groups of flying fish, a dozen or so at a time, kept taking off and flying directly into the wind. Presumably the plane frightened them, for in a few minutes I saw enormous numbers take to the air, almost always nearly under us. The flights usually consisted of three or four hops, separated by the brief periods of sculling described above. The over-all time of the flights varied roughly from 6 to 18 seconds; *i.e.*, the single hops lasted about 3 to 5 seconds. At least once I could clearly see the acceleration of the fish during its brief period of sculling on the surface between hops, and once I distinctly saw the undulating wake of the fish's tail, looking like a row of dots on the surface of the water.

The procedure as described seems to be well established, and is an interesting combination of the efficiency of aquatic propulsion and the low resistance attained by airfoil support.

ALEXANDER FORBES

HARVARD MEDICAL SCHOOL

PROPULSIVE POWER USED BY FLYING FISH

IN my brief note in SCIENCE for January 24 under the above title, I failed to make proper mention of the excellent articles of Dr. Carl L. Hubbs in this field,[1] in which he described the repeated tail lashings by which flying fish renew their propulsive impetus in the course of a compound flight.

In his articles, however, he fails to describe the apparently intentional tail lowering by which the fish is enabled to "taxi" off for another glide without the immersion of more than the tip of the tail. One would infer that the movement is accomplished by a folding of the pelvic fins, which provide lifting power for the rear portion of the body when they are extended in the air. Such folding gives the downward tilt that dips the tail into the water.

C. A. MILLS

UNIVERSITY OF CINCINNATI

PRESENT STATUS OF THE "GEOLOGY OF NORTH AMERICA"

WHEN the writer undertook to bring out the "Geology of North America" to be published by Gebrüder Borntträger in Berlin, with Professor Erich Krenkel in Leipzig as general editor, it was his conviction that, owing to his lack of knowledge in many fields to be covered, it would be necessary, in order to make the work authoritative, that the principal chapters should be entrusted to recognized authorities in their respective fields. This has been done to such an extent that some thirty geologists agreed to collaborate, most of whom have responded with splendid contributions.

A few of the older collaborators, however, have found it impossible to find the time to write their chapters. The result of this has been an unfortunate delay leading to the fear that these missing chapters, about half a dozen, may not be delivered.

This fact, together with the advice received by the writer from the Regents of the University of the State of New York that, owing to his advanced age, he should restrict himself to his graptolite work and aim to finish that, made it necessary to turn the completion of the "Geology of North America" over to a younger, energetic and competent scholar. Such has been found in Professor Balk, of Mount Holyoke College, who is well known by his studies of batholiths and structural problems both in the east and west of North America.

It is hoped that younger geologists can be engaged for the lacking chapters. Meanwhile Professor Balk will begin to bring out in separate instalments the chapters already finished, after bringing them up to date, in which arduous task the writer is assisting him.

Some of the lacking chapters are of great importance, and this notice should be considered by energetic geologists as an appeal to assist in the work. So many manuscripts of great scientific value have been already received that it would mean an irreparable loss to science if the work should not be completed along the original lines.

Correspondence should be addressed: Professor Robert Balk, Mount Holyoke College, South Hadley, Mass.

RUDOLF RUEDEMANN

STATE MUSEUM, ALBANY, N. Y.

SCIENTIFIC BOOKS

HISTORY OF SCIENCE

A History of Science, Technology and Philosophy in the 16th and 17th Centuries. By A. WOLF, with the cooperation of F. DANNEMANN and A. ARMITAGE. pp. xxvii + 692, with 316 illustrations. The Macmillan Company, New York, 1935. $7.00.

A COMPREHENSIVE history of science is badly wanted. To write such a book, to trace the develop-

[1] Papers of Mich. Acad. Sci., Arts and Letters, Vol. 17, 1932; and Smithsonian Reports for 1932, pp. 333–348.

ment of human civilization in its scientific aspects is a gigantic but marvelous task. It has to be done by one man. A group of experts could at best produce a good reference book but not a history. Only one man can, during a lifetime of study, assimilate the materials and experience the history of science so strongly that he feels compelled to recreate it in a broad synthesis. The idea of such a book would be to work out the leading general ideas of the various periods and to follow them up into the various sciences. It would soon be recognized that the same attitudes and trends were responsible for developments in mathematics, physics, biology, in all the sciences. Specialized as the sciences may have been, their essential unity would soon appear. How did the sciences fit into the life of a period, how were they determined by it, how did they affect it? These are vital questions that would have to be discussed.

It may be objected that it is too early to write such a book, that our knowledge of the facts is not sufficient as yet and that infinitely more research has to be done before such a synthesis can be attempted. This may be true, and yet I think that every generation of scientists should see such a book written. In every generation the scientist should pause for a while, should look back into the past of his science, try to determine where he stands and what tasks history has assigned to him. Every generation would look at history with different eyes, but with every generation the picture would become more colorful—it would be stimulating always. History is an instrument of life, and a well-written history of science could not but influence research.

We received Professor Wolf's book with great expectations but were sadly disappointed. The present volume discusses the sixteenth and seventeenth centuries. Other volumes dealing with the eighteenth and nineteenth centuries, with antiquity and the middle ages will follow. It is hard to understand how a historian can begin his narrative in the middle. I can not think of a composer writing the third movement of a symphony first nor of an architect building a house without foundations. It is the same with a historical book. Granted that the Renaissance brought forth new scientific ideas and methods, but it is impossible to understand them if one is not familiar with Greek and medieval science. Leonardo da Vinci can not be understood without Nicolaus Cusanus. After all, Duhem's and Cassirer's studies, not even mentioned in this book, can not be bluntly disregarded. To picture a figure like Paracelsus one has to discuss the background of Greek and Arabic medicine on one side, of German medieval mysticism on the other side. The idea that modern science is the real science, born in the sixteenth and seventeenth centuries, and that what precedes is merely the prehistory of science, the work of forerunners does not hold any longer. There are different ways of investigating nature.

What spoils the whole book is that Professor Wolf adopted the most unfortunate pattern of Dannemann's history of science,[1] splitting up the entire material according to special sciences. After an introductory chapter the book begins with the Copernican revolution, Galileo, scientific academies, scientific instruments, astronomy, Newton, mathematics, then discusses the history of physics, meteorology, chemistry, geology, geography, the biological sciences, medicine, technology, and it finally ends with three chapters on psychology, the social sciences and philosophy.

This classification of sciences was adopted "on grounds of simplicity and orderliness," "to make things clearer than they would be otherwise." The opposite resulted, a complete confusion. Leonardo's work is discussed in fifteen different places scattered all over the book from page 5 to page 544, and the reader does not get the faintest idea of Leonardo's unique personality. Galileo is given a whole chapter, justly so, pages 27–53, but then Santorio is discussed on pages 431–435, Harvey's work on pages 411–415, and yet the point would just have been to show what unites these men, what they have in common in spite of the fact that they worked in different fields. After all, when we have to teach students, our task is not to present them with mere facts that they can find in any encyclopedia, but to show them the links between the facts, to give them a vivid impression of developments and trends.

Due to this unfortunate arrangement Professor Wolf's book is not a history of science but a collection of brief essays on the history of various scientific disciplines. The book will, undoubtedly, appeal to the teachers of science who will very conveniently find materials there for the first lecture of their courses and pictures for lantern slides. The book is profusely and very well illustrated. I would not recommend it to the students. It is not a history and, as a reference book, it is not comprehensive nor accurate enough. In most cases the new literature has not been consulted. To-day one can not discuss the history of the circulation of the blood any longer without mentioning Ibn an-Nafiz. The studies of Ostachowski and Pagel have placed van Helmont in a new light. An utter lack of originality is felt throughout the book. We never know what Professor Wolf really thinks. He piles facts upon facts without digesting them. Whenever

[1] Friedrich Dannemann, "Die Naturwissenschaften in ihrer Entwicklung und in ihrem Zusammenhange," volumes I–IV, 2d edition. Leipzig, 1920–1923.

there are two divergent views on a subject, he usually adopts the old traditional view without telling us why he rejects the new researches.

It certainly was an excellent idea to devote chapters to psychology, the social sciences and philosophy, but philosophy should have been treated in the beginning, not at the end, or, better still, it should have permeated the whole book.

The chapters on technology are very welcome also, but they make you realize that history of technology without economic history is a dead skeleton.

I always feel depressed after reading such a book. A political history, a history of literature or history of art of such composition and standard would be inconceivable to-day. While it is history of science, it is accepted and will probably find a market. It shows that, in spite of all efforts, we are still in the very beginning.

A history of science is still wanted. Professor Wolf's book is not a history, I repeat it. It is at best what Professor L. N. G. Filon, F.R.S., calls it on the jacket, "a mine of useful, yet delightful information."

HENRY E. SIGERIST

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OUR ENEMY, THE TERMITE

Our Enemy, the Termite. By THOMAS ELLIOT SNYDER. 8vo, pp. xii plus 196. Frontispiece, 9 plates, 55 text illustrations. Comstock Publishing Company, 1935. $3.00.

I BELIEVE that there is no one in America who could write a better book on the termites than Dr. Snyder. He has worked on the general subject for twenty-six years and, after an excellent training at Columbia and the Yale Forest School, he has been spending his time with striking success as an investigator in the branch of forest insects in the U. S. Bureau of Entomology and Plant Quarantine. He has traveled widely, has made many important scientific discoveries, and has, unlike many scientific men, kept the public needs constantly in view. He has also, again unlike many men of science, learned to write in a very attractive and understandable way. All this makes possible this very interesting and much-needed book.

SCIENCE of March 30, 1934, printed on pages 296 and 297 a review of mine of the big book just then published by the University of California under the chief editorship of C. A. Kofoid, on "Termites and Termite Control." And in this laudatory review I called especial attention to the fact that it was a most worthy object-lesson as a *cooperative* effort, containing chapters by no less than thirty-three authors treating of the different aspects of the economic termite problem. In that truly great book, Dr. Snyder's name occurs as the writer of four chapters and he has published many government bulletins and shorter papers on different sides of the subject. I am very thankful that with all his knowledge—taxonomic, biologic and economic—he has put down in this useful volume, and before it is too late, just what we all want to know and should know.

Man, perhaps the most disturbing ecologic factor in the biologic history of the world, seems, in his rapid advance, apparently to have brought about a situation that has changed a useful group into a destructive one, and the economic side of the termite question has become very important. Almost every one knows about termites now, and recently we may almost say that there has been a termite scare. Just how far this has been due to the exploitation of "Termite Destroyers" I don't know, but conservative scientific men like Dr. Snyder are inclined to think that some exaggeration has been produced in the popular mind. In fact the outlook is by no means so bad as it might be, or as some would wish us to think it. As the author tells us, "With modern stone and steel construction in cities, and more durable foundations for frame buildings, there should be a decrease of termite damage to the woodwork of dwellings."

The book is not only scientifically sound, but it is eminently practical. It lacks the philosophical speculation with which Maeterlinck and many other writers have clothed the termite idea and that of social insects in general, but it devotes many pages to control methods and shows in a vivid way why building and loan associations, insurance companies and banks have been really forced to cooperate in the urging of revised building codes. It is encouraging to know that these revised building codes have been adopted during recent years by many towns and cities, and are now enforced.

But possibly what I have written has placed too much weight on the practical side of the book to please those who think of termites only as wonderful and very mysterious creatures. I hope not, for there are chapters that deal intimately with life histories, social organizations, geographical distribution, guests or inquilines, the disturbance of the balance of nature by man, and so on. And actually the subject of control takes up less than half. And then there is a good glossary and a competent index and the make-up is excellent, and the many illustrations are very apt.

I will not attempt to describe further what is in this admirable treatise. To even enumerate the headings of the chapters would take too much space. But it is a most timely book and it is a most important book. It answers conclusively the questions that many thousands of people wish to ask. No better authority on this subject than this volume can be consulted.

L. O. HOWARD

SOCIETIES AND MEETINGS

FIRST NORTH CENTRAL STATES FISH AND GAME CONFERENCE

NEARLY 200 persons interested in wildlife research from Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio and Wisconsin met at Urbana, Illinois, December 5 and 6, 1935, for the First North Central States Fish and Game Conference. This meeting was the outgrowth of correspondence between the chief of the Illinois Natural History Survey and conservation administrators and biologists in neighboring states. The purpose of this parley was to discuss research problems and methods pertaining to the preservation and sound utilization of wildlife resources and to develop more coordinated and cooperative investigational programs between the states represented.

For two days, December 5 and 6, the conference listened to more than forty scientists in discussions of a wide range of subjects concerning fish and game conservation. On December 7 more than fifty were guests of the Illinois Natural History Survey on a field trip to Havana, Illinois, and the Illinois River about 100 miles west of Urbana. Those attending the field trip were shown wildlife habitats typical of the Illinois River bottomland territory and learned of the survey's research involving the state's resources of fish and game.

Because of the large attendance and variety of the program the conference was divided into general, fisheries and game sections. The general section was opened by T. H. Frison, who presided as general chairman of the meeting and banquet, with a talk pointing out the need for such a parley and reasons for confining the call for the conference to the states in attendance. Appearing on the program of the general section were: W. C. Allee, professor of zoology, University of Chicago; Samuel A. Graham, professor of economic zoology, University of Michigan; Byron L. Groesbeck, assistant chief senior forester, Region Nine, National Forest Service; R. G. Green, Department of Bacteriology and Immunology, University of Minnesota; Ernest G. Holt, in charge wildlife conservation, U. S. Soil Conservation Service; Will Scott, professor of zoology, Indiana University; Victor E. Shelford, professor of zoology, University of Illinois; Milton B. Trautman, assistant director, Institute for Fisheries Research, University of Michigan; Harley J. Van Cleave, professor of zoology, University of Illinois; and Leonard W. Wing, Department of Agricultural Economics, University of Wisconsin.

The banquet, which on Friday evening closed the general discussions, crowded nearly 300 persons into the Urbana-Lincoln Hotel to hear J. N. Darling, Aldo Leopold, W. B. Bell, A. M. Bailey and S. Barry Locke cover the field of wildlife investigations and programs from angles of criticism, commendation, reproof, explanation, encouragement and appeals for cooperation.

J. N. "Ding" Darling, recently resigned chief of the U. S. Biological Survey, made clear his resignation as "due to completion of the job I went to Washington to do." Scoring wildlife enthusiasts for failing to unite to secure legislation in protection of fish and game, Mr. Darling took some of the sting out of his remarks by humorous interpretation of factors behind Congressional legislation, or lack of it, on wildlife. W. B. Bell, chief of the Division of Wildlife Research, U. S. Biological Survey, emphasized the cooperative aspects of federal wildlife conservation work in the north central states. S. B. Locke, conservation director of the Izaak Walton League of America, spoke about the league's efforts at popular education for appreciation of wildlife values by sportsmen and others. A. M. Bailey, director of the Chicago Academy of Sciences, showed and explained motion pictures which he had made in several parts of the United States. His subjects ranged from migratory waterfowl of many kinds to moose, hawks, antelope and bears of the Yellowstone. Aldo Leopold, in charge of game research investigations, University of Wisconsin, illustrated by means of lantern slides his subject, "A Day's Hunt on an Estate in Silesia." The peculiar system of game management in that part of Germany and the type of sport it affords were the basis of Mr. Leopold's talk, which he selected from his experiences while abroad this summer studying game management practices in Europe.

On the program of the fisheries section were: Harry E. Adams, National Forest Service; W. W. Aitken, Iowa Conservation Commission; A. E. Andrews, Indiana Department of Conservation; F. A. Brown, Jr., University of Illinois; C. F. Culler, U. S. Bureau of Fisheries; Chancey Juday, University of Wisconsin; T. H. Langlois, Ohio Conservation Division; Lee S. Roach, Ohio Conservation Division; C. L. Schloemer, University of Wisconsin; Will Scott, Indiana University; T. Surber, Minnesota Department of Conservation; David H. Thompson, Illinois Natural History Survey; Milton B. Trautman, Institute for Fisheries Research, University of Michigan; John Van Oosten, U. S. Bureau of Fisheries; and E. L. Wickliff, Ohio Conservation Division.

The game section had an extensive program on which appeared: Logan J. Bennett, U. S. Biological Survey; Rudolf Bennitt, University of Missouri; H. L. Blakey, National Forest Service; J. N. Darling, Des Moines, Iowa; Paul L. Errington, Iowa State College;

Gill Gigstead, Wisconsin Department of Conservation; George O. Hendrickson, Iowa State College; Lawrence E. Hicks, U. S. Soil Conservation Service; Ralph T. King, University of Minnesota; Aldo Leopold, University of Wisconsin; Frederick C. Lincoln, U. S. Biological Survey; Miles D. Pirnie, W. K. Kellogg Bird Sanctuary, Michigan State College; H. D. Ruhl, Michigan Department of Conservation; George Saunders, Michigan Department of Conservation; R. E. Trippensee, Massachusetts Agricultural College; Farley F. Tubbs, Michigan Department of Conservation; Douglas E. Wade, University of Wisconsin; E. L. Wickliff, Ohio Conservation Division; H. M. Wight, School of Forestry and Conservation, University of Michigan; and R. E. Yeatter, Illinois Natural History Survey.

The Illinois Natural History Survey, as host organization of the meeting, held open house on Thursday night, December 5, and invited conference members and townspeople to inspect its laboratories and offices located on the campus of the University of Illinois, and later to see several reels of new wildlife motion pictures.

The conference voted to make an annual affair of the meeting so successfully initiated at the first parley, not to have a constitution or formal organization, and to preserve the open discussion system which characterized the Urbana gathering. Ann Arbor, Michigan, was selected by the assemblage as the place for the next meeting, and Dr. Samuel A. Graham, of the University of Michigan, was appointed by a special committee to act as chairman for the 1936 conference.

T. H. FRISON

SPECIAL ARTICLES

THE INFLUENCE OF HYPERPNEA AND OF VARIATIONS IN THE O_2- AND CO_2-TENSION OF THE INSPIRED AIR ON WORD-ASSOCIATIONS

IN three preceding papers, Gellhorn and Spiesman[1] have investigated the influence of variations in the O_2- and CO_2-tension in the inspired air and of voluntary hyperpnea on several cortical processes (vision, hearing), as well as on a brain stem reflex (caloric nystagmus). It seemed desirable to extend these investigations to a quantitative study of higher mental processes for two reasons: (1) to improve our understanding of the nervous and mental symptoms following profound anoxemia and similar conditions; (2) to compare the effect of the same factors on physiological cortical processes (vision, hearing) and on one of those which are commonly designated to-day as psychic processes.

The experiments were carried out with the Kent-Rosanoff[2] association test, which consists of 100 words standardized on 1,000 normal persons so that the usualness of response can be expressed quantitatively. Fifty words served as a control and the other fifty words were used in order to study the effect of O^2-lack, etc., on associations. In control experiments carried out on 25 subjects the associations formed to the first 50 words were compared with those obtained from the second 50 words. The associations were divided into four groups corresponding to their frequency in the Kent-Rosanoff tables. The total number of responses was determined for each of the four groups (comprising the individual responses (0-group), and those occurring 1–15, 16–100, and more than 100 times in the frequency tables), and the change between the first and the second 50 associations was expressed in percentage of the former (heavy line in Fig. 1). The

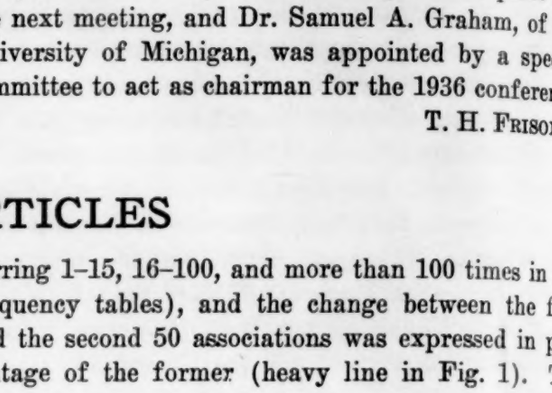

FIG. 1

Ordinate: change in usualness of response between the first and the second 50 words expressed in percentage of the former.

Abscissa: 0 = individual responses, 1, 2, 3 = responses with the frequency 1–15, 16–100, and more than 100 respectively.

Heavy line = control.

Thin line = the effect of 0_2-lack.

figure indicates that the frequency of responses remains practically the same in both groups of 50 words under standard conditions.

Hereafter fifty experiments on O_2-lack were carried out with 31 normal subjects, who inhaled N_2-air mixtures (O_2 between 7.3 per cent. and 11 per cent., in the majority of experiments 8 to 9 per cent.) from a Douglas bag for 6 to 10 minutes.

[1] E. Gellhorn and I. Spiesman, *Proc. Soc. Biol. and Med.*, 32: 46 and 47, 1934; and *Am. Jour. Physiol.*, 112: 519, 620 and 662, 1935.

[2] G. H. Kent and A. J. Rosanoff, *Am. Jour. Insanity*, 67: 37, 1910.

Since we were more interested in any shift which might occur in the usualness and type of association than in the association time, the latter was not determined and the experimental subjects wrote the association words as answers to the stimulus words which were dictated to them. Twenty-nine control and O_2-lack experiments, in which the distribution of the associations according to their frequency was determined by the Kent-Rosanoff tables, were calculated as the control experiments described above. The result represented in the thin line of Fig. 1 is that O_2-lack brings about a marked shift in the type of response toward the more individual reactions. Moreover, it is found that the number of perseverations (repetition of the same response) increases under O_2-lack to an extent inversely proportional to the O_2-concentration inhaled. Finally, it must be mentioned that under such O_2-lack not infrequently entirely irrelevant reactions (dissociations) occur.

Experiments in which the effect of various O_2-concentrations on associations was studied on the same subject proved strikingly that the changes in associations mentioned above are due to O_2-lack, since they gradually increased with decreasing O_2-concentration. One illustration may be given in the following table, which is self-explanatory:

THE INFLUENCE OF O_2-LACK ON ASSOCIATONS. SUBJECT W

	Number of perseverations	Number of dissociations
Control	3	0
9.8 per cent. O_2	7	0
8.65 per cent. O_2	10	3
7.93 per cent. O_2	15	9

CO_2 experiments (6 to 9 per cent.) were carried out under similar conditions with similar results. In general, the CO_2 effect is less than that of O_2-lack.

This holds true, also, for the effects of hyperpnea. But in all three groups of experiments the resulting changes in the association response were the same and consisted in: (1) an increased number of individual and less frequent reactions; (2) an increased number of perseverations; (3) the occurrence of dissociations. It is obvious from these results that the alteration in cortical excitability due to O_2-lack, CO_2-excess and hyperpnea leads to similar changes in vision and hearing, as well as in associations, whereas CO_2-excess and diminution in CO_2 due to hyperpnea have opposite effects on tendon[3] and vestibular[4] reflexes. As to the type of change in associations observed in our experiments, it may be said that it is similar to those observed in some mental diseases.[5] There was no general parallelism between the discomfort felt by the subjects (dyspnea, etc.) and the changes recorded.

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[3] C. E. King, W. E. Garrey and W. R. Bryan, *Am. Jour. Physiol.*, 102: 305, 1932; Strughold and Jörg, *Zeitschr. f. Biol.*, 94: 150, 1933.

[4] Gellhorn and Spiesman, *loc. cit.*

[5] Kent and Rosanoff, *loc. cit.*

THE INFLUENCE OF THE ADRENAL GLANDS ON CALCIUM METABOLISM[1]

IN a previous communication,[2] one of us summarized evidence indicating a functional interrelationship between the adrenal and parathyroid glands. Mention was made of observations on disturbances in calcification of dentin in rats' incisors induced by excess of parathyroid extract. These changes were found to be similar or identical with those which follow bilateral adrenalectomy in rats.

Characteristic disturbances in calcification of dentin occur in the incisors when both adrenal glands are excised, in rats. They are manifested by the presence of globules disseminated throughout the predentin of the middle third of the incisor.

The "globular predentin" stains, with eosin and haematoxylin, like intermediate dentin. It was not present in nearly a thousand rats that were observed in other studies, in which adrenalectomy was not performed, except in three animals that received single large doses of parathyroid extract and were examined 19 hours later.

Other evidences of disturbed calcification in the dentin are deep staining of the labial dentin by haematoxylin and prominent stratification in the lingual dentin. In adrenalectomized animals that survived up to about 10 days the post-operative dentin could be distinguished from the pre-operative by the presence of a deeply stained band corresponding to the portion of dentin that was laid down and calcified about the time of the operation. The presence of this band permits measurement of the post-operative dentin. The organic matrix of the dentin is laid down at the rate of 16 μ daily, therefore, the width of the post-operative dentin, expressed in μ, when divided by 16 will yield the survival period of the animal. The calculated survival period corresponded remarkably with the actual period noted in our experimental records.

In adrenalectomized rats whose survival was prolonged by the presence of accessory adrenal bodies, the characteristic globular predentin was absent. They showed changes similar to those found in rickets, *viz.*, wide predentin (40–84 μ) and prominent inter-

[1] From the Department of Histology, College of Dentistry, University of Illinois, and the Physiological Laboratory, University of Chicago. This investigation was

globular dentin. This observation suggests the probability of a relation of disturbed adrenal function to the calcium disturbances associated with the development of rickets.

The results obtained in our experiments afford interesting information on calcification processes of enamel and dentin. In a small number of animals the enamel-forming cells (ganoblasts) showed intracellular globules which stained deeply with haematoxylin.

Occurrence of globular predentin in adrenalectomized rats, as in animals that were subjected to the action of parathyroid extract, confirms the observation that adrenal insufficiency is associated with disturbances in calcium metabolism.[3] It also lends support to the suggestion of a functional interrelationship between the adrenal and parathyroid glands. Indeed, it seems possible that the disturbances in calcium metabolism, which lead to the changes in the dentin, in adrenalectomized animals, may be the result of functional disturbances in the parathyroid glands. Although evidence favors the probability that the adrenal cortex is primarily involved, the possible relation of the medulla has not been excluded in these experiments.

The foregoing summarizes our observations on a series of 45 bilaterally adrenalectomized rats. Details of the experiments will be included in another paper, to be published elsewhere in the near future.

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LIGHT AND REPRODUCTION IN GAME BIRDS[1]

GROUSE, quail and pheasants were irradiated in open air cages for six hours after sunset from December 14, 1935, to January 16, 1936, at the Experimental Game Farm of the New York State Conservation Department. A 50-watt Mazda lamp suspended over each experimental cage gave an illumination of 10 foot-candles in the center of the floor.

Due to the cost of the birds, few could be sacrificed, but the following results showed undoubted effects.

Pheasants: Hatched on August 8, 1935. In five control females weights of ovary varied from 72 to 160 milligrams. In the single experimental animal, ovary weighed 176 milligrams, an increase of 31 per cent. over control average. In five male controls, weights of testes were from 70 to 164 milligrams. In one experimental bird, the weight of the testes was 702 milligrams, an increase of 463 per cent.

Quail: Hatched in spring, 1935. In three female controls, ovary weighed 48 to 57 milligrams, with an average of 52 milligrams. One experimental female yielded an ovary weighing 210 milligrams, an increase of 307 per cent. In three male controls, weights of testes were from 13 to 23 milligrams with an average of 18 milligrams. One experimental bird gave testes weighing 313 milligrams, an increase of 1,740 per cent.

Grouse: Hatched in spring, 1935. Single female control gave an ovary weighing 157 milligrams, and an experimental female gave an ovary of 263 milligrams, an increase of 68 per cent. A single male control gave testes weighing 27 milligrams, while an experimental bird yielded testes weighing 600 milligrams, an increase of 2,080 per cent.

Although the number of experimental birds is small, the great differences between the size of the gonads in control and irradiated pheasants, quail and grouse show that light has a profound stimulating effect upon the reproductive organs. Sections of the testes of the irradiated males revealed fully formed sperm associated with enlarged tubules, but not a single sperm or spermatid was seen in the control testes. The females in all cases did not respond to the same degree as the males. However, hormonic stimulation of the ovaries of the irradiated females was observed by the enormous increase in the size of the oviducts.

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ANOPHELES EXPERIMENTALLY INFECTED WITH MALARIA PLASMODIA

DURING a recent study of anopheline mosquitoes caught in dwellings on the military reservation at Fort Sherman, Canal Zone, the author found a specimen of *A. punctimacula* which was naturally infected with malaria plasmodia, the stomach showing five oocysts, all of which contained sporozoites. Since this observation, which was reported at the 1935 meeting of the American Society of Tropical Medicine,[1] experiments have been conducted with a view to determining the relative importance of *A. punctimacula* as a malaria vector.

aided by grants from the Graduate Research Board of the University of Illinois and the Commodore Beaumont Foundation.

[2] J. M. Rogoff, SCIENCE, 80: 319, 1934.

[3] J. M. Rogoff and G. N. Stewart, *Am. Jour. Physiol.*, 86: 25, 1928.

[1] Research supported in part by assistance of grant-in-aid of the Society of Sigma Xi and the Rockefeller Foundation.

[1] J. S. Simmons, "*Anopheles* (*Anopheles*) *punctimacula* Naturally Infected with Malaria Plasmodia." Read by W. H. W. Komp at the meeting of American Society of Tropical Medicine, St. Louis, Mo., November 20–22, 1935. To be published in the March issue of the *American Journal of Tropical Medicine.*

It is the purpose of this progress note to announce that during February, 1936, it has been shown experimentally that laboratory-reared *Anopheles* (*Anopheles*) *punctimacula* (Dyar and Knab) when fed on the blood of suitable malaria patients, are susceptible to infection with either *Plasmodium vivax* or with *P. falciparum*.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

DEVICE FOR THE MOTOR CONDITIONING OF SMALL ANIMALS[1]

SOME time ago[2] a conditioning apparatus for use with cats was published from this laboratory. That piece gave useful service, but another apparatus is now available which far excels it in speed and reliability of training and testing.

The present model is adapted from the ordinary rotating cage, used for measuring the general activity of small animals; and is so constructed that the cat, upon turning the cage an inch or more when the sound (substitute stimulus) begins, escapes the shock by breaking the high-voltage circuit through a pendulum-switch. Details of construction, as provided in mimeographed form by the technical staff of this laboratory, will be furnished gratis upon application to either of us.

In testing the apparatus, a considerable number of animals (20 cats, 12 guinea pigs, 5 male white rats) were first used. By our earlier methods of training, a large proportion of cats always proved intractable; hence we decided to try every cat in our colony and thus find what proportion of an unselected population would work acceptably. By this preliminary test (15 to 25 trials with 1,000 cycle tone) they were divided into three groups: A, those which began reacting to the tone during these initial trials (8); B, those which by reacting well to the shock gave promise of early conditioning (9); C, those which, being unresponsive, were discarded (3). Those in A and B were then given 25 additional trials, the percentage of conditioned responses (shock avoidance) being as follows:

Group A	96%	96	88	88	64	40	40	36	
Group B	84%	64	60	48	40	24	20	8	8

Despite these encouraging results, the crucial question still remained: How will the rotator work in limen-determination? It is here that most methods fail. Cats will often do well enough with loud or complex sounds; but when a sinusoidal stimulus of low intensity is used, they may fail to react even once to tones which are known to be quite audible to them. Then, for reasons just as obscure as their former refusal, they may suddenly begin responding at a level many decibels weaker than before. With faint stimuli cats are notoriously erratic.

Two cats were accordingly chosen for threshold work, the limens being measured at three frequencies (125, 1,000 and 8,000 cycles) with the technique regularly employed at this laboratory;[3] see adjoining table.

Cat	125 cycles 1	125 cycles 2	1,000 cycles 1	1,000 cycles 2	8,000 cycles 1	8,000 cycles 2
	52	50	68	68	40	46
	54	50	70	66	36	46
	50	48	70	66	38	44
	50	46	70	68	36	44
	52	48	68	64	36	44
Mean	51.6	48.4	69.2	66.4	37.2	44.8
Standard error of mean ...	0.75	0.75	0.49	0.75	0.80	0.49

These limens, measured directly after the initial 50 trials, are as consistent (low standard errors) as are the scores of representative dogs after weeks or even months of training (*cf.* footnote 3, 226). Since these initial tests, we have used the method with many other cats in our systematic programs and have found it equal in reliability and far superior in speed to our dog-training methods.

The guinea pigs scored as follows in the second of two series of 25 trials (numbers represent percentage of conditioned responses): 88, 64, 52, 48, 20, 20, 20, 20, 20, 16, 8, 8. Though somewhat inferior to the cats, they did better than was expected. Their explosive mode of response makes them peculiarly refractory to ordinary methods of training; apparently because the conditioned stimulus must be built up to unusual potency ere it can break down the high initial resistance of the pig's sensori-motor system. In view of their thyratron-like behavior, the scores of the pigs in the rotator seem to be notably good. The five rats, finally, gave these scores in the second 25 trials: 64, 60, 40, 44, 36.

Credit for suggesting the use of a rotating cage in this type of work is due the first-named author; but we share the conviction equally, derived both from quantitative evidence like the above and also from observing the animals when they work, that a real advance has been made in the business of training laboratory animals. The rotator combines various advantages. (1) It employs the shock-incentive, which, unlike food, is stable and unfailing, even when the animal's economy, visceral or somatic, is gravely disturbed (newly op-

[1] Communication No. 20 from the Animal Hearing Research, Department of Psychology; maintained by aid of the Research Council of the American Otological Society. The present investigation was aided by a grant from the Josiah Macy, Jr., Foundation.

[2] Culler, Finch and Girden, SCIENCE, 79: 525, 1934.

[3] Culler, Finch, Girden and Brogden, *Jour. General Psych.*, 12: 223, 1935.

erated, sick, decorticate.) (2) The activity required of the animal is easy and familiar. Instead of a localized, differential response (retraction of the right fore-paw), any gross somatic behavior will do. The cage turns so readily as to require minimal incentive or energy. (3) It gives the animal unhampered freedom of limb movement and thus obviates "fighting the apparatus." Any form of restraint is particularly resented by cats. (4) Its principal feature is probably that no response is incorrect. With most devices, everything the animal may spontaneously do is wrong except the one reaction imposed by the experimenter; hence most of the training-time is consumed in extinguishing or inhibiting false starts. Here on the contrary, any movement gross enough to turn the cage is adequate. If the animal tries to escape, it also turns the cage; whether it walks forward, backward or sidewise is immaterial. Only inactivity is unacceptable.

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AN AID IN COLOR-BLINDNESS

THE general assumption relative to color-blindness seems to have been that no artificial aid was possible for persons suffering from the condition. Actually, such a pessimistic attitude is not justified in the case of this or almost any other sensory deficiency. The inconveniences of color-blindness can be partially offset by proper use of color-filters.

For example, there appear occasional news items telling of color-blind persons who have learned to distinguish the red and green traffic lights by their positions in the signal and who have then been thrown into confusion by trying to apply their method of discrimination in a town where the practice is different as regards the position of the two lights. These stories have resulted in some attempts at standardization of the signals, but irregularities of practice still exist.

An infallible and simple expedient for the color-blind person faced by this situation is to affix red and green color-filters, one above the other, to the windshield of his car in such a way that their positons can not become accidentally interchanged. Because red and green are complementary colors, the red signal will be visible only through the red filter and the green signal through the green.

The device is improved by placing a prism or reducing lens over each filter in such a way that the signal will be visible through both filters at the same time.

In this form, that is to say, with the lenses, the idea has been tried out and found operative.

The experimental model as constructed by the writer employed red and green Eastman Wratten filters designated as 25A and 58B, respectively. These were mounted side by side between two pieces of glass, with a minus 3 diopter lens in front of each filter. Suction cups were provided for affixing the device to the windshield of a car, tests being made with color-blind volunteers both in traffic and in the laboratory.

Another possibility is that one of the color-filters might be perforated, and parts of the other set in it like polka-dots. Thus, if the red filter were perforated and the openings were filled with the green material, a red traffic light or other red object viewed through the resulting filter would appear bright with dark spots. A green object, on the other hand, would appear dark with bright spots. This is a type of discrimination which would be easy for the color-blind person.

Red-green color-blindness is probably not the only type that could be offset by the expedient of using color-filters, but to prescribe the suitable filters for other less well-defined types would be an undertaking requiring careful study and justified only in the event that the afflicted individuals can be persuaded to make use of the aid.

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